QH105
M5
A3
no.4

The D. H. Hill Library

North Carolina State University

QH105
M5
A3
no.4

W. O. HOTCHKISS

THIS BOOK IS DUE ON THE DATE INDICATED BELOW AND IS SUBJECT TO AN OVERDUE FINE AS POSTED AT THE CIRCULATION DESK.

100M/5-78

MICHIGAN GEOLOGICAL AND BIOLOGICAL SURVEY.

Publication 20.
Biological Series 4.

MISCELLANEOUS PAPERS

ON THE

ZOOLOGY OF MICHIGAN.

PREPARED UNDER THE DIRECTION OF

ALEXANDER G. RUTHVEN

CHIEF NATURALIST

PUBLISHED AS A PART OF THE ANNUAL REPORT OF THE BOARD OF GEOLOGICAL SURVEY FOR 1915

LANSING, MICHIGAN
WYNKOOP HALLENBECK CRAWFORD CO., STATE PRINTERS
1916

BOARD OF GEOLOGICAL AND BIOLOGICAL SURVEY, 1915.

EX OFFICIO:

THE GOVERNOR OF THE STATE,

HON. WOODBRIDGE N. FERRIS.

THE SUPERINTENDENT OF PUBLIC INSTRUCTION,

HON. FRED L. KEELER.

THE PRESIDENT OF THE STATE BOARD OF EDUCATION,

HON. THOMAS W. NADAL.

DIRECTOR,

R. C. ALLEN.

SCIENTIFIC ADVISORS.

Geologists.—Dr. L. L. Hubbard, Houghton; Prof. W. H. Hobbs, Ann Arbor; Prof. W. H. Sherzer, Ypsilanti.

Botanists.—Prof. E. A. Bessey, East Lansing; Prof. F. C. Newcombe, Ann Arbor.

Zoologists.—Prof. W. B. Barrows, East Lansing; Prof. J. Reighard, Ann Arbor; Dr. Bryant Walker, Detroit.

73694

LETTERS OF TRANSMITTAL.

To the Honorable the Board of Geological and Biological Survey of the State of Michigan:

Gov. Woodbridge N. Ferris.
Hon. Fred L. Keeler.
Hon. Thomas W. Nadal.

Gentlemen:—I have the honor to transmit herewith some miscellaneous papers on the zoology of Michigan, prepared under the direction of Dr. Alexander G. Ruthven, Chief Naturalist, with the recommendation that they be printed and bound as Publication 20, Biological Series 4.

Very respectfully,

R. C. ALLEN,
Director.

Sir:—I present herewith for publication six papers on the zoology of Michigan, by Thomas Hankinson, Roy J. Colbert, Arthur T. Evans, Crystal Thompson, and Arthur W. Andrews. The investigations upon which these papers are based are a part of or supplement the biological work of the Survey, and the data which they contain materially increases our knowledge of the fauna of the State.

Respectfully,

ALEXANDER G. RUTHVEN,
Chief Naturalist.

R. C. Allen, Director,
Michigan Geological and Biological Survey.

CONTENTS.

	Page
bservations on the Fishes of Houghton County, Michigan, by Thomas L. Hankinson	11
Local Distribution of Fish	13
Stonington Lake	13
South Twin Lake	14
North Twin Lake	19
Kratt Lake	20
Bear Lake	20
Conclusion	21
List of Species	22
n Ecological Study of the Fish Fauna of the Douglas Lake Region, Michigan, with Special Reference to the Mortality of the Species, by Roy J. Colbert	25
ragonflies of the Douglas Lake Region, Michigan, by Arthur T. Evans	37
Topography of the Region	39
Taxonomy	41
Discussion and Summary	55
Bibliography	57
he Reptiles and Amphibians of Monroe County, Michigan, by Crystal Thompson	59
List of Species	62
esults of the Mershon Expedition to Charity Islands, Lake Huron: Coleoptera, by A. W. Andrews	65
Habitat Distribution of Coleoptera	67
List of Species	71
esults of the Shiras Expeditions to Whitefish Point, Michigan: Fishes, by T. L. Hankinson	109
General Description of Whitefish Point Region	112
Topography	112
Vegetation	114
Invertebrates	116
Vertebrates other than Fish	118
Climatic Features	119
Methods and Acknowledgements	121
Fish Habitats	122
Lake Superior Shoal	123
Beach Ponds	124
Marsh Lakes and Streams	127
Shelldrake Lake	136
Shelldrake River	137
List of Species	139
Hypothetical List of Species	152
Summary and Conclusions	156
Bibliography	159

LIST OF ILLUSTRATIONS.

			Page
Plate I		General view of east shore of South Twin Lake, looking south from Station 1	32
Plate II.		South Twin Lake, looking northwest, showing broad shoal with a scant rush growth and the zones of shore vegetation	32
Plate III.		South Twin Lake, Station 3, looking northwest, showing the region fished as far as the rushes extend	32
Plate IV.		South Twin Lake, looking north, showing an unusually broad beach but with many encroachments of the small shrub zone	32
Plate V.		South Twin Lake, Station 13, looking north	32
Plate VI.		South Twin Lake, Station 7, looking east. Floating Sparganium leaves not shown on account of waves	32
Plate VII.		South Twin Lake, Station 46, looking northwest	32
Plate VIII.		South Twin Lake, Station 40, looking west. Mouth of Misery Creek	32
Plate IX.		Figure A, adult of *Hetaerina americana* (Fabricius)	58
		Figure B, adult of *Agrion aequabile* (Say)	58
		Figure C, nymph of *Macromia illinoiensis* Walsh	58
		Figure D, adult of *Agrion maculatum* Beauvais	58
		Figure E, adult of *Anax junius* (Drury)	58
		Figure F, nymph of *Hagerius brevistylus* Selys	58
Plate X.		Figure A, labium of a nymph of *Macromia illinoiensis* Walsh	58
		Figure B, figure of *Hagenius brevistylus* Selys	58
		Figure C, figure of the labium of *Agrion aequabile* (Say)	58
		Figure D, side view of the abdomen of *Hagenius brevistylus* Selys	58
		Figures E and F, fore and hind wings of *Anax junius* (Drury)	58
Plate XI.		Map of the Whitefish Point region, Chippewa County, Michigan	160
Plate XII.	A.	Lake Superior beach at Vermilion. Upper and lower beach shown; the latter with *Ammophila arenaria* zone, shown chiefly in the foreground	160
	B.	Lake Superior beach with sand ridge crossed by Cranberry Creek, just east of Vermilion	160
Plate XIII.	A.	Lake Superior beach, looking east toward Vermilion during a storm. Showing formation of temporary pools by waves	160
	B.	Small portion of Lake Superior beach showing pebble zone and small temporary pond	160
Plate XIV.	A.	Lake Superior beach with dunes of the first sand ridge	160
	B.	Cranberry Creek (Station 30), looking north and down stream, showing a part of the beach pool formed by it (Station 31)	160
Plate XV.	A.	Pond on Lake Superior beach (Station 31) formed by Cranberry Creek	160
	B.	Beaver dam and pond on Mason's Creek (Station 171)	160
Plate XVI.	A.	Beach pond in the course of Mason's Creek	160
	B.	Marsh bordering Mason's Creek (Station 172) on Lake Superior beach	160
Plate XVII.	A.	Looking southwest from high sand dune near Station 101, showing marsh and sand ridges with upland in distant background	160
	B.	Marsh Lakes, looking southeast from the high dune near Station 101	160
Plate XVIII.	A.	Channel east from Beaver Lake (Station 90)	160
	B.	Channel of Vermilion Lake (Station 25)	160
Plate XIX.	A.	Marsh bay of Beaver Lake (Station 55), looking southwest (lakeward)	160
	B.	The same, looking south	160

			Page
Plate XX	A	Marsh bay of Beaver Lake (Station 52), looking northeast	160
	B	Northwest shore of Beaver Lake (Station 59), looking northeast	160
Plate XXI	A	Spruce Lake, looking northwest (Station 71)	160
	B	Station 84, Spruce Lake, looking east. Floating mats of stonewort on the surface	160
Plate XXII	A	Station 85, Spruce Lake, looking south across the east end of the lake	160
	B	Marshy north shore of Vermilion Lake	160
Plate XXIII	A	Steep lake and wooded sand ridge about a half mile east of Vermilion (Station 106), looking northeast	160
	B	West end of the small lake shown in A. Station 101, looking east	160
Plate XXIV	A	Mitten Lake, Station 116, looking east	160
	B	Vermilion Creek at Vermilion. Great Blue Heron feeding	160
Plate XXV	A	Shelldrake Lake, looking southwest	160
	B	Northwest shore of Shelldrake Lake, looking northeast (Station 142)	160
Plate XXVI	A	Shelldrake River just portion of wooded swamp, looking downstream from a high north stream bank	160
	B	Portion of Shelldrake River just south of Vermilion	160
Plate XXVII	A	Shelldrake River just south of Shelldrake Lake, looking south	160
	B	Long-nosed Dace, *Rhinichthys cataractae*	160
Plate XXVIII	A	Mastodon Tubbies, *Lymnodrilus pollicis* (?), caught at Station 2, Lake Superior	160
	B	Young Whitefish, *Coregonus hoyaeformis* (pollicis area), length of largest about three inches, caught at Station 1, on Lake Superior shoal	160

FIGURES

Figure 1	Outline map of South Twin Lake, Houghton county, Michigan	13
Figure 2	Sketch map of Hungry Lake, Michigan	41
Figure 3	Sketch map of the Mount Lake region near Vermilion	113

OBSERVATIONS ON THE FISHES OF HOUGHTON COUNTY, MICHIGAN.

THOMAS L. HANKINSON,

STATE NORMAL SCHOOL, CHARLESTON, ILLINOIS.

OBSERVATIONS ON THE FISHES OF HOUGHTON COUNTY, MICHIGAN.

THOMAS L. HANKINSON.

During the latter half of August, 1905, the writer made a study of the fish in a number of small lakes in Houghton County, Michigan, for the Michigan Geological and Biological Survey. Most of the work was done on lakes lying along the Copper Range Railroad between Stonington and Winona, two small stations nearly ten miles apart and in general between seventeen and one-half and twenty-seven and one-half miles southwest of Houghton by rail. Only two lakes at any distance from this ten-mile stretch of railroad were examined—Kratt Lake, about two miles southeast of Winona, and Bear Lake, about seven and one-half miles north of Houghton in the sand dune region of Lake Superior.

As it was impossible in the time devoted to the work to make a detailed study of all of the fish environments in each lake, attention was principally confined to one kind of habitat—the shallow water, three feet or less in depth, about the shores and islands. Each habitat was seined with a six foot "common sense" seine, and in addition to observations on abundance, notes were made on the ecological distribution. A complete series of the fish taken in each place has been deposited in the Museum of Zoology, University of Michigan.

The writer is indebted to A. C. Lane, former State Geologist, for helpful suggestions in the course of the work, to A. G. Ruthven for assistance in the preparation of this paper for publication, and to the following persons for aid in identifying material: C. A. Davis, seed plants; A. G. Ruthven, reptiles and amphibians; S. E. Meek, three species of minnows; Edwin Linton and H. B. Ward, fish parasites; F. S. Collins, algae; J. P. Moore, leeches; N. A. Harvey, sponges.

LOCAL DISTRIBUTION OF FISH.

Stonington Lakes. Three small lakes close to the station of Stonington on the Copper Range Railroad are called the Stonington Lakes in this paper. Each of these lakes is surrounded by thick forest except where they come close to the railroad embankment. They are in general oblong in shape, and the largest is perhaps a quarter of a mile

D. H. HILL LIBRARY
North Carolina State College

in length. As in all of the lakes of this densely forested region south of Houghton, the water has an umber color, and the bottom material of the shoals is similar to that found in the shallow water of the other lakes—a firm sand tinged with the color of the water.

The lakes were examined and a number of collections made on August 25. No detailed study of the vegetation was attempted, but the following plants of special interest were noted:

Marchantia polymorpha L.—Growing in abundance on beaches.

Drosera rotundifolia L.—Abundant on the shore and extending out on partly floating logs.

Equisetum fluviatale L.—Growing in patches, and in places forming distinct zones along the water's edge.

Ericaulon articulatum (Huds).—Forming patches on the bottom in shallow water.

Myriophyllum Farwellii Morong.—On submerged portions of logs.

Potomogeton sp.?—In patches in deeper water.

Brasenia Shreberi Gmel.—In patches.

Gloiotrichia Pisum (Ag.) Thuret.—An alga forming gelatinous colonies in shallow water.

Conspicuous aquatic invertebrates noted were:

Spongilla lacustris (Linn.).—On brush and other submerged objects near shore.

Macrobdella decora (Say).—Apparently the common leech of the northern lakes about Houghton.

Caddice worms.—Common on the bottom of shoals. Their cases were made of sticks.

Two amphibians occurred in some numbers around the shores, *Rana septentrionalis* Baird and *Rana pipiens* Schreber.

The fish observed were:

Chrosomus erythrogaster.—Abundant in schools in both lakes.

Pimephales promelas.—Abundant in large schools in both lakes.

Couesius plumbeus.—One taken in the south lake.

Catostomus commersonii.—One caught in the south lake.

Pygosteus pungitus.—Eight taken in the middle lake.

Eucalia inconstans.—Two found in the middle lake.

South Twin Lake. This lake is located about three miles northeast of Winona, on the Copper Range Railroad. It is somewhat over a mile long and a half mile wide, and receives several small streams. The outlet (Plate VIII) is Misery Creek, which flows to the west into Lake Superior (Fig. 1). The lake is completely surrounded by the forest except for a small clearing about the single building on its shore (Plate II). A well-marked beach, continuous with a broad shoal of compact

Figure 1.

sand or gravel, is present in most places. The water and bottom are tinged with umber.

South Twin lake received the most attention of the two. Stations were located in typical habitats and rather detailed studies were made at these places. Here again, the work was principally confined to the shallow water. Upon the beaches were sedges, rushes, and many other plants, forming in most places a thin growth of vegetation. A distinct zone of low shrubs, chiefly *Myrica Gale* (L.) and *Chamaedaphne calyculata* (L.) Moench, almost completely surrounds the lake just outside the beach region. Outside this is a zone of high bushes, and then comes the timber region, which is mainly composed of hardwoods but also includes many conifers, conspicuous among which are some large white pines.

The plants noted on the shoal were:

Bulrushes.—Formed a scant growth over many shoals. Thick patches were unusual.

Sparganium sp?—Often formed a thick growth in shallow water.

Ericaulon articulatum (Huds).—A rather conspicuous growth in places where there were but a few inches of water.

Lobelia Dortmanna L.—Found growing with the *Ericaulon*.

Potomogeton.—Several species grew on the shoal, principally on the outer part.

Brasenia purpurea Casp.—Patches were often present on deeper shoals.

Habitat Distribution of Fish in South Twin Lake.

Station 1. This is the shoal and adjacent shore at the extreme north end of the lake. The shallow water area is comparatively extensive with a bottom of hard sand. Over this is a scant growth of rushes, which form the only conspicuous vegetation. The shore zones of plants are distinct, but the low bush or heath zone practically covers the beach (Plate II).

Fishing with the hand seine was done on the morning of August 28 in water that was mostly between one and two feet in depth. The water temperature was 70° F. Fish were few and were not moving on the shoal: those taken were found resting beneath objects such as overhanging bushes, an old row boat and pieces of water-logged bark. The following species were collected:

Rhinichthys atronasus lunatus.—Several taken.

Semotilus atromaculatus.—Several small specimens taken.

Micropterus salmoides.—One small specimen 4.2 cm. long was caught.

Station 3. This is a shoal which differs from that of Station 1 in being much narrower, a depth of three feet being reached about thirty or forty feet out from the shore. The shore features are similar to those of Station 1, and this is also true of the bottom which is composed of a similar hard, reddish sand with little vegetation (a few rushes and other plants). Many logs (Plate III) were floating near the shore. Collecting was done with the six-foot minnow seine in water three feet or more in depth and there was no difficulty in getting a representative collection of fishes for they showed little fear of the net.

The invertebrates found were:

Macrobdella decora.—This large leech was common.

Dragon-fly nymphs and eggs of *Tetragoneuria* sp.—The latter were in long strings of jelly-like substance.

Caddice worms.

The fish taken were:

Semotilus atromaculatus.—Small specimens found in water less than a foot deep.

Chrosomus erythrogaster.—Many in shallow water near shore. A large, compact school was seen in three feet of water.

Rhinichthys atronasus lunatus.—Chiefly in the shallow water near shore.

Couesius plumbeus.—Three small specimens.

Leuciscus neogeus.—One taken.

Catostomus catostomus.—About a dozen small ones were taken and one comparatively large specimen, nearly a foot long, was found sucking on the submerged part of a floating log on the wood freshly bared by the stripping off of a portion of the bark.

Eucalia inconstans.—One taken.

Micropterus salmoides.—Small specimens under four inches in length were common in a few inches of water near shore.

Perca flavescens.—Small specimens under three inches in length were common. They were confined to the deeper part of the shoal in two or three feet of water and were found in compact schools.

The first three species of fish mentioned in this list were closely associated and tended to school together.

Station 16. A stretch of shore different from that of any other part of the lake is found at this station (Plate IV). The beach is unusually broad with low bushes scattered over it, and the shoal is also peculiar in that the bottom is covered with large pebbles over which no fish were found. The only place where fish were seen was in a shallow beach pool which was connected with the lake by a short, narrow channel. This little bay is scarcely more than a square yard in area and only an inch or so in depth. Many small fish were observed, and as the writer approached, they began to hasten through the little channel to the lake. A collection of these fish contained representatives of *Semotilus atromaculatus, Rhinichthys atronasus lunatus, Couesius plumbeus, Eucalia inconstans and Lepomis cyanellus.* All were small individuals of their species, and the Semotilus was most abundant, only one of each of the last four species being taken.

Station 13. As shown on the map, this station is at the end of a little bay. There is a diversity of conditions, but the whole region is a shoal with more aquatic vegetation than any of the stations yet described. In places the water reaches a depth of about four feet. The bottom is mostly hard and sandy, but close to the south end of the bay there is a thin layer of humus over the sand. Plate V shows a part of the eastern portion of the bay.

Rushes were abundant, and there was a good sized patch of *Brasenia Shreberi.*

The following invertebrates were found in this habitat:

Spongilla lacustris (Linn.) and *Spongilla fragilis*, Leidy.—These two

formed a conspicuous green growth on the submerged branches of a tree that had fallen into the water. This tree can be seen in Plate V.

Macrobdella decora.—A few were seen and collected.

Two species of fish were found, *Catostomus catostomus* (one small specimen) and *Micropterus salmoides* (small specimens, less than two inches long), the latter being common.

Station 7. Sparganium (Plate VI), growing in patches in one to two feet of water, covered much of the bottom of the shoal called Station 7. Except for many long slender leaves floating on the surface, the plants were submerged at the time studied. Beyond this growth, toward deep water, was a zone of pond weeds (*Potomogeton Nuttallii* and perhaps other species of the genus), followed by a zone of water lilies, which occupied the deepest part of the shoal and extended out to the beginning of deep water. A small, sandy delta at the mouth of a little creek entering the lake at this point broke the *Sparganium* zone.

The following fish were caught on the shoal, but a representative collection could not be made on account of the denseness of the vegetation: *Semotilus atromaculatus, Rhinichthys atronasus lunatus, Lepomis cyanellus, Micropterus salmoides.* Only a few small specimens of each of the listed species were taken. Ten of the small *Semotilus* caught were infested with a protozoan parasite, *Myxobolus.* Many small fishes were seen.

Station 46. The shoal with the greatest amount of plant life of any visited is on the west side of the lake and just north of a small point of land. This is called Station 46. No attempt will be made to describe the complex association of plants found in this habitat, but an idea of its general character may be had from Plate VII. The water is mostly three or four feet deep and the sand is covered by several inches of humus.

As at Station 7, the abundance of vegetation did not permit careful seining. Many fish, including some large *Semotilus atromaculatus* 100-120 mm. long, were seen, showing that this was a favorite fish habitat, and even from the small amount of data obtained it was evidently the type most favored by shoal fish. A noteworthy feature was the great abundance of red-bellied leeches, *Macrobdella decora,* which, while found at other stations in some numbers, were nowhere so abundant as on this shoal.

The following fish were found at this station:

Semotilus atromaculatus.—Many seen, none taken.

Leuciscus neogeus.—Three small specimens collected.

Micropterus salmoides.—Many small bass were seen but none were

captured. The habitat undoubtedly represented an important feeding ground for them.

Perca flavescens.—One small specimen taken.

Deep Water Region.—As previously stated, the deep water region, by which is meant all of that extensive portion of the lake surrounded by the relatively narrow shoals, was scarcely examined in any of the lakes, but in this lake, a little hook and line fishing, done just off the shoal called Station 1, yielded seven *Perca flavescens* (130-160 mm. long); and just off the lily zone of Station 7, in deep water, two rather large *Lepomis cyanellus* (150-180 mm. long) and a *Micropterus salmoides* (265 mm. long) were taken.

Stream at Station 7. The stream already referred to as entering the lake at this station is a very small one, and fish were found only close to its mouth, in a deep pool (as deep as four feet in places). Satisfactory collecting could not be done with a net, but a number of good sized *Semotilus atromaculatus* (10-15 cm. long) were caught there with a hook and line baited with worms.

Station 40. This is the area about the head of Misery Creek, the principal and perhaps the only outlet of the lake. The general character of the region is shown in Plate VIII. The water is very deep at the source of the creek, but about a bridge and for a considerable distance below it, the stream is shallow enough to permit fishing with the small seine. In the center of the stream the depth averages perhaps three feet. The bottom is of hard sand covered in places with considerable brush and other forest debris. Fish tended to keep under the bridge, where they were abundant; few were found in the other part of the creek visited. The following species were noted and collected:

Chrosomus erythrogaster.—Abundant; many large specimens, 60-70 mm. long were taken.

Semotilus atromaculatus.—Abundant; many large specimens, 120 or more mm. long, were taken. As many as two dozen of these large chubs were caught at a haul with the six-foot seine.

Rhinichthys atronasus lunatus.—Abundant; many large specimens, some 100 mm. long, were collected.

Leuciscus neogeus.—Two were taken, each about 70 mm. long.

Couesius plumbeus.—Common. They were mostly about 50 mm. long.

Perca flavescens.—Five were taken, 50-70 mm. in length.

Micropterus salmoides.—One taken, about 40 mm. long.

North Twin Lake. This lake lies to the north and east of South Twin Lake and is considerably the larger of the two. Very little work was

done there, only about an hour being spent in collecting along the south end. It appeared to be surrounded by unbroken forest except at the south end where lumbering was going on. The bottom and vegetation seemed to be like those of South Lake. Many fish were observed in the shallow water area, and the following five species were taken: *Chrosomus erythrogaster, Semotilus atromaculatus, Rhinichthys atronasus lunatus, Catostomus catostomus, Lepomis cyanellus.* With the exception of *Rhinichthys atronasus lunatus*, which was very common, only a few specimens of each species were caught.

Kratt Lake. Kratt Lake is located about two miles southeast of Winona, mostly south of Sections 33 and 34, Township 52. It is surrounded by dense forest except for the clearing about an inhabited house. It is smaller but similar to South Twin Lake in the character of the bottom and vegetation; and the shoal, as far as observed, is narrower. The same brown-stained water and bottom sand was found as in the other forest lakes visited. The sand beach is more or less obscured by the zone of low bushes, outside of which is a zone of high bushes and beyond this the timber region. The small shrubs bordering the beach, and in places covering it, seemed to be entirely of two species—*Myrica Gale* and *Chamaedaphne calyculata.*

The following strictly aquatic plants were found: *Sparganium* sp? (forming large, dense, submerged patches in places), *Potamogeton natans* L., *Fontinalis antipyretica* L., *Myriophyllum Farwellii, Utricularia vulgaris* L., *Tolypothrix tenuis* Kutz, *Batrachospermum* sp?

Sponges were abundant but none were collected.

Only the following two species of fish were found:

Lepomis cyanellus.—This species was very abundant, and took a baited hook greedily. In fact, the great abundance and voracity of this sunfish was a prominent characteristic of this lake. In a short time, seventy individuals around 15 cm. in length were caught. They seemed to be most abundant in the deep water just off the shoal. In the shallow water a few small specimens (20-30 mm. in length) were taken, but no other species were found in this shoal region.

Perca flavescens.—One small specimen, about 100 mm. long, was taken by hook.

All of the fish taken in Kratt Lake were very dark in color with a decided umber tinge like that of the water.

Bear Lake. Bear Lake is out of the region of the other lakes studied and already considered. It is in the brush-covered sand dune area

about a half mile from Lake Superior and about seven and a half miles directly north of Houghton. The lake is nearly a mile long with an average width of perhaps a quarter of a mile and presents conditions very different from those in the lakes in the forest south of Houghton. The water is clear and the sand unstained. The shoal is variable in extent; in some places it is narrow and in others one can wade out a hundred feet or so from shore.

Bulrushes were more or less abundant in different parts of the shallow water region, and formed dense and extensive patches. There was also a growth of stoneworts on the bottom, associated with some gelatinous and filamentous green algae which appeared to be chiefly Zygnema and Spirogyra.

Two small crayfish, *Cambarus* sp?, were taken here, the only place in the county where they were found.

Only the shoal was fished, on August 23, but an attempt was made to get a representative collection. The following species were obtained:

Pimephales notatus.—Rather common.

Abramis chrysoleucas.—One small specimen (30 mm. long) taken.

Notropis cayuga.—This species was common and occurred in large schools. The specimens were mostly from 60-70 mm. long.

Perca flavescens.—Small specimens about 40 mm. long were common in shallow water.

Etheostoma iowae.—A number were found on the sandy bottom.

The fish found in Bear Lake were of normal coloration and not umber-tinged as were all of those found in the umber-colored water of the forest lakes.

CONCLUSION.

As has already been stated, the work upon which this paper is based was only a reconnaissance made for the purpose of obtaining a general knowledge of the fishes and fish environments in the lakes of the region. Study was centered on the shoals since in that habitat more species, and thus a better representation of the fauna, could be obtained in the time that could be given to the work. The main value of the report must then be the additional data on the distribution of the species in the state and the general information on the fish faunas of the lakes of this region which it contains.

Five general conclusions may be drawn from the ecological data given above and that contained in the list of species which follows.

(1). The forest lakes examined, which have apparently very similar conditions, have quite different fish faunas.

(2). All of the fishes from the stained waters of the forest lakes are very dark in color, their bodies being tinged with the same color as the water.

(3). In August the shoal fishes are generally most abundant where there is most aquatic vegetation.

(4). Fish enemies in the form of parasites appear to be very frequent in the lakes examined.

(5). South Twin Lake is one of the northern lakes that may be advantageously studied to determine its suitability as an environment for the black bass. The young evidently thrive there, and one of size was caught which was in very good condition. The many minnows in the lake might furnish a large quantity of available food for the bass.

LIST OF SPECIES.

The following list comprises only the species actually secured or observed by the writer, and, as has been said, is principally confined to the shoal species. It is of course incomplete, but it contains additional data on the distribution of the species. The nomenclature and the order of consideration are, with a few modifications, those used in Jordan and Evermann's Fishes of North and Middle America. The millimeter numbers given refer to the length of the fish, which was taken from the tip of the snout to the posterior end of the caudal fin.

1. *Catostomus catostomus* (Forster). Long-nosed Sucker.—Found only in Twin Lakes, where it appeared to be common.

2. *Catostomus commersonii* (Lacépède). Common Sucker.—A single small specimen (36 mm.) taken from South Stonington Lake.

3. *Chrosomus erythrogaster* Rafinesque. Red-bellied Dace.—Common in both Twin Lakes and in each of the two Stonington Lakes examined. In the latter, it was found schooling with *Pimephales promelas*. The specimens collected measured 21-63 mm. One fish with bright red under-parts was found.

4. *Pimephales promelas* Rafinesque. Fat-head Minnow.—Taken only at Stonington, where it was abundant in both of the lakes studied. Two hundred and four specimens (22-60 mm.) were collected. Three were found with cestodes (probably Ligula) filling their body-cavities and greatly distending their abdomens.

5. *Pimephales notatus* (Rafinesque). Blunt-nosed Minnow.—Found only at Bear Lake, where thirteen were taken (24-35 mm.).

6. *Semotilus atromaculatus* (Mitchill). Horned Dace.—The horned dace was only observed in Twin Lakes where it was abundant. Only small specimens, 60-70 mm. long, were found on shoals, but large ones (100-155 mm.) were in streams close to the lake. The fish were much infested with a protozoan parasite, Myxobolus, which produced whitish swellings of the skin and often made the fish conspicuous. Of the two hundred and thirteen specimens preserved, thirty-five were diseased

with this parasite. They are parasitized internally as well as externally, for fourteen parasitic worms, Echinorynchus, were found in their alimentary canals. A superficial examination was made of the digestive tracts of ten large dace (103-143 mm.) and the contents observed were as follows: elytra and other parts of beetles, pieces of dragon-fly and May-fly nymphs, small spiders, winged ants, a small amphipod, some pieces of wood, and the vertebral columns of two frogs. The two hundred and thirteen specimens preserved measured 27-155 mm.

7. *Leuciscus neogeus* (Cope).—Eight (44-70 mm.) were taken from South Twin Lake.

8. *Abramis chrysoleucas* (Mitchill). Golden Shiner.—Only one very small specimen (31 mm.) was observed. This was found in Bear Lake.

9. *Notropis cayuga*, Meek.—Common at Bear Lake but none were found elsewhere in the region. Twenty-four specimens (61-66 mm.) were taken.

10. *Rhinichthys atronasus lunatus* (Cope). Black-nosed Dace.—Noted only in Twin Lakes, where it was present in considerable numbers. The fifty-five specimens preserved measured 25-98 mm.

11. *Couesius plumbeus* (Agassiz).—Found in some numbers in South Twin Lake. Forty-two were taken, the measurements of which were 40-50 mm.

12. *Salvelinus fontinalis* (Mitchill). Brook Trout.—A common fish in the streams. None were found in lakes, but the writer was told that they frequent the shoals in the spring, retiring into the deep water in summer, when they rarely take a hook.

A few small specimens were taken by hook in a small branch of Sleepy Creek, at Winona. On three small specimens (46-84 mm.) four large copepod parasites (probably Lernaepoda) were found.

13. *Esox lucius* L. Common Pike.—The writer saw fish of this species that had been taken in a small lake located some seven miles southeast of Winona. This lake is said to contain so many of these fish that it is called "Pike Lake."

14. *Eucalia inconstans* (Kirtland). Brook Stickleback.—Six specimens of this stickleback were collected at Stonington and South Twin Lake. They measured from 32-53 mm.

15. *Pygosteus pungitus* (Linnaeus). Nine-spined Stickleback.—Found only at Middle Stonington Lake where eight were taken from a single school. They measured 42-49 mm.

16. *Lepomis cyanellus* Rafinesque. Blue-spotted Sunfish.—Found in small numbers at Twin Lakes and very abundant at Kratt Lake. Those collected measured 20-166 mm. An examination of the digestive tracts of ten specimens, averaging about 120 mm. in length, showed

the fish in Kratt Lake to be feeding on animal and plant material. The stomach contents were as follows: insect fragments (heads of hemipterous insects and parts of beetles), pieces of wood, alga fragments, leaves of Sparganium or Ericaulon, and water lily seeds.

17. *Micropterus salmoides* (Lacépède). Large-mouth Black Bass.—Small specimens were very abundant on shoals of South Twin Lake, but none were noticed elsewhere. Those caught measured 34-78 mm. in length. In the stomachs examined were fish bones, teeth of a minnow, entomostracans, and Chironomus larvae. One comparatively large specimen (265 mm.) was caught with hook and line in South Twin Lake.

18. *Perca flavescens* (Mitchill). Yellow Perch.—Found at South Twin Lake, Bear Lake and Kratt Lake. Small specimens were generally distributed on shoals in South Twin Lake. Some of those taken were 43-70 mm. long. None were found on the shoals of Kratt Lake or Stonington Lakes. Larger perch (133-185 mm.) were taken from deep water off the shoals in South Twin Lake, Bear Lake and Kratt Lake.

19. *Etheostoma iowae*, Jordan and Meek.—Found only in Bear Lake, where four were taken in shallow water on a sandy bottom. These were 37-45 mm. in length.

AN ECOLOGICAL STUDY OF THE FISH FAUNA OF THE DOUGLAS LAKE REGION (MICHIGAN) WITH SPECIAL REFERENCE TO THE MORTALITY OF THE SPECIES.

ROY J. COLBERT

THE UNIVERSITY OF TOLEDO.

D. H. HILL LIBRARY
North Carolina State College

AN ECOLOGICAL STUDY OF THE FISH FAUNA OF THE DOUGLAS LAKE REGION (MICHIGAN) WITH SPECIAL REFERENCE TO THE MORTALITY OF THE SPECIES.

ROY J. COLBERT.

In this study of the fish fauna of the Douglas Lake (Michigan) region special attention was given to the mortality of the various species found and it is thought that the data collected in this connection have a direct bearing on the general ecology of the species involved. In order that the data on the mortality might be more easily understood, records of species frequency were taken for several typical habitats and a general survey of the intra-lake distribution of the species made. The collection of fishes from which the data were gathered includes several hundred specimens taken during the summer sessions of 1913 and 1914 at the University of Michigan Biological Station at Douglas Lake.

Opportunities for procuring data on these particular problems were especially favorable. Douglas Lake affords an ample variety of aquatic habitats which are easily accessible for study. The shores of the lake are covered with their natural growth of vegetation and timber, and as yet neither the inlets nor the outlet, Maple River, have been dredged or changed to any large extent. The lake and its adjacent waters may be divided into the following units for the purpose of this study: North Lake, that part of Douglas Lake west of Fairy Island and Robert's Point; North Fishtail Bay; Bessey Creek region together with the other small inlets of the lake; and Maple River (See map, Fig. 2). Each of these regions has a condition or set of conditions distinguishing it from the others and encouraging the predominance of certain species of fish.

The prevailing winds of the region blow from the west and northwest, hence North Lake, the part of Douglas Lake west of Fairy Island and Robert's Point, is seldom disturbed by heavy winds and waves, and the aquatic vegetation, especially *Myriophyllum* and *Potomogeton*, has a better chance to grow. This is particularly true immediately west of Fairy Island. In this region the pike-pickerel, *Esox lucius*, and the rock bass, *Ambloplites rupestris*, are very common, and along the marshy shallows of the west shore the cat fish, *Amieurus melas*, nest and are found in great abundance.

North Fishtail Bay affords two somewhat different habitats. The north portion is a quiet bay surrounded by a thick pine and cedar

forest. The water increases in depth very gradually from the shoals along the shore. The bottom here is covered with a thin layer of decayed vegetation and the yellow water lilies, *Nymphaea americana*, *Potomogeton*, and *Myriophyllum* are very abundant. This particular habitat was studied from two standpoints: (1) to ascertain the relative frequency of the various species belonging in this habitat, breeding and feeding there, and (2) to learn what fishes come into the habitat to feed. Several nests of the catfish, *Amieurus melas*, and the pumpkin seed, *Eupomotis gibbosus*, were found both summers early in July with the adults still guarding them. Several schools of small catfish were seen all through the summer in the very shallow water near the bank.

The frequency study of this habitat was made by placing a fyke net in the bay, about 100 feet from the shore, with the wings extending almost to the shore on either side and with the open mouth of the trap toward the shore. The trap in this position collected the fishes belonging to the habitat, and breeding and feeding there. The following table gives the results of six days typical collecting.

TABLE NO. 1.

Species.	Number.	Average size.	Frequency.
1. Pumpkin seed, *Eupomotis gibbosus*	63	100 m.m.	.583
2. Blue gill, *Lepomis pallidus*	24	108 m.m.	.223
3. Sucker, *Catostomus commersonii*	14	276 m.m.	.130
4. Cat fish, *Amieurus melas*	7	177 m.m.	.064

During the two summer's work, in addition to the species listed in the table, two specimens of the yellow perch, *Perca flavescens*, and one trout perch, *Percopsis guttatus*, were taken in the net. Both of these species are from deeper water and were in this habitat presumably by accident.

To determine what species enter the habitat to feed, a gill net was set across the bay just outside the fyke net. Particular care was taken to note in what direction each fish entered the net, i. e., whether it was coming in from the lake or going out into deep water. The following table gives the results of six days collecting with the gill net:

TABLE NO. 2.

Species.	Number of individuals.	Direction.		Average size.
		In.	Out.	
1. Sun fish, *Eupomotis gibbosus*	18	0	18	121 m.m.
2. Sucker, *Catostomus commersonii*	14	4	9	294 m.m.
3. Pickerel pike, *Esox lucius*	6	6	0	360 m.m.
4. Blue gill, *Lepomis pallidus*	3	0	3	126 m.m.

It will be seen from Table No. 2 that all *Eupomotis gibbosus* and *Lepomis pallidus* were inside the enclosed area and were caught going out. *Catostomus commersonii*, however, were taken on both sides of the net and near the bottom where they feed. The frequency of this particular species all over the lake, except in very deep water, is practically the same, and as expected it occurs in both shallow and deep water. *Esox lucius*, however, belongs in a different habitat in deeper water. Since none were taken in either the fyke net or on the inside of the gill net, it is quite evident they visit the habitat for feeding. The nets were emptied every morning and evening, and about as many of the various species were taken at one time as another, except *Esox lucius*, which in every instance was gilled at night during the usual time of feeding.

The combined frequency of all species collected in this habitat, including visitors, as shown by the combined collections, is as follows:

TABLE NO. 3.

Species.	Average size.	Frequency.
1. Pumpkin seed, *Eupomotis gibbosus*	111 m.m.	.534
2. Blue gill, *Lepomis pallidus*	117 m.m.	.180
3. Sucker, *Catostomus commersonii*	285 m.m.	.180
4. Catfish, *Ameiurus melas*	177 m.m.	.047
5. Trout perch, *Percopsis guttatus*	110 m.m.	.006
6. Yellow perch, *Perca flavescens*	120 m.m.	.007
7. Pickerel-pike, *Esox lucius*	360 m.m.	.039
8. Bowfin, *Amia calva*	700 m.m.	.007

The south bay of North Fishtail Bay presents a situation more nearly like that of the lake proper. It gets about the same amount of wind and wave action; its bottom is sandy and drops abruptly from a narrow, shallow shoal to a depth of 40 feet. It has, however, along the edge of the step-off and in the shallows of the south side, where the wind and waves have less sweep, a considerable patch of yellow water lilies, *Nymphaea americana* and *Potomogeton*. The fyke net was placed in this situation for a period of ten days with the open mouth of the trap toward the shore. The catch, therefore, while it represents the relative frequency of the species in the habitat, was not large. The result of the collections is as follows:

TABLE NO. 4.

Species.	Number.	Average size.	Frequency.
1. Pumpkin seed, *Eupomotis gibbosus*	5	148 m.m.	.217
2. Large-mouthed black bass, *Micropterus salmoides*	3	173 m.m.	.131
3. Small-mouthed black bass, *Micropterus dolomieu*	1	210 m.m.	.043
4. Sucker, *Catostomus commersonii*	4	332 m.m.	.173
5. Catfish, *Ameiurus melas*	2	200 m.m.	.087
6. Blue gill, *Lepomis pallidus*	3	116 m.m.	.131
7. Rock bass, *Ambloplites rupestris*	3	131 m.m.	.131
8. Yellow perch, *Perca flavescens*	2	145 m.m	.087

The fish taken from this habitat were larger than those of the same species taken from the north bay. The presence of both the large-mouth black bass, *Micropterus salmoides,* and the small-mouth black bass, *Micropterus dolomieu,* in the ratio of three to one, is a characteristic feature of this habitat.

The lake proper has four types of habitats, each of which must be dealt with separately: (1) the shallows and shoals; (2) the deep water near the step-off; (3) the mid-lake portion not exceeding 20 feet in depth; and (4) the deep cold water below the 20 foot line which includes most of South Fishtail Bay. (See map, Fig. 2).

In the shoals and shallows of South Fishtail Bay schools of young perch, *Perca flavescens,* shiners, *Notropis hudsonius, N. cayuga,* and *N. cornutus,* young suckers, *Catostomus commersonii,* blunt-nosed minnows, *Pimephales notatus,* and an occasional individual of the Johnny darter, *Boleosoma nigrum,* are found. Each of these species, however, is very abundant on the more rocky shoals between Grapevine and Bogardus Points, on the east side of Fairy Island, and along the northeast side of the lake (See map, Fig. 2). The relative frequency of these various species is seen in the following table, the combined results of seven different long-shore seinings made at various times during the sessions of 1913 and 1914:

TABLE NO. 5.

Species.	Number.	Average size.	Frequency.
1. Yellow perch, *Perca flavescens*	642	40-60 m.m.	.381
2. Sucker, *Catostomus commersonii*	360	30 m.m.	.214
3. Hudson's shiner, *Notropis hudsonius*	344	20-60 m.m.	.204
4. Johnny darter, *Boleosoma nigrum*	285	20-40 m.m.	.169
5. Common shiner, *Notropis cornutus*	34	20-60 m.m.	.020
6. Blunt-nosed minnow, *Pimephales notatus*	11	30 m.m.	.008
7. Cayuga shiner, *Notropis cayuga*	5	30 m.m.	.003
8. Pumpkin seed, *Eupomotis gibbosus*	1	10 m.m.	.0006

Practically all of the records included in Table 5 were adults of the species, excepting the perch, suckers, and pumpkin seeds. The adults of these three species frequent the deeper water of the lake, but lay their eggs in the shallows where the young remain until they are large enough to avoid the enemies commonly found in the deeper waters. Since the young suckers and perch are so abundant they form a very important part of the life of this habitat.

Just over the step-off, in water ranging from 10 to 20 feet deep in situations where the aquatic vegetation is more or less abundant, the trout perch, *Percopsis guttatus,* and yellow perch, *Perca flavescens,* are very abundant. Here also the schools of the log perch, *Percina caprodes,* are found, but the last species is by no means as abundant as the other two. The largest schools of the log perch were found

Figure 2.

near the east shore of South Fishtail Bay, where during the first two weeks of July they were seen spawning in the shallow water. Adult minnows are also fairly frequent in this habitat. As will be seen later, the great majority of adult yellow perch thrown upon the beach by the waves were stranded while feeding on the trout perch in this habitat, practically every individual having a half-swallowed trout perch in its mouth.

Over the submerged sand bar and on either side of it, where the reeds, *Scirpus* spp., grow, also between Grapevine Point and Fairy Island, where the various water plants grow to within four to six feet of the surface, the habitat is slightly different. Here the bass, both *M. dolomieu* and *M. salmoides*, the pickerel-pike, *Esox lucius*, and the rock bass, *Ambloplites rupestris*, are abundant. A trammel net placed with one end barely on the sand-bar, i. e. in about 10 feet of water, and the other end extending into water forty feet deep gave the following results during both sessions:

TABLE NO. 6.

	Species.	Average size.	Depth of water.	Number.	Frequency.
1.	Rock bass, *Ambloplites rupestris*..	135 m.m.	10-15 ft.	52	.305
2.	Sucker, *Catostomus commersonii*...	310 m.m.	At all depths	38	.222
3.	Pumpkin seed, *Eupomotis gibbosus*	110 m.m.	7-10 ft.	28	.164
4.	Pickerel-pike, *Esox lucius*.....	440 m.m.	20-40 ft.	21	.123
5.	Catfish, *Amieurus melas*.....	320 m.m.	At all depths	17	.099
6.	Small-mouthed black bass, *Micropterus salmoides*.....	380 m.m.	20-40 ft.	10	.058
7.	Yellow perch, *Perca flavescens*....	160 m.m.	10-20 ft.	3	.017
8.	Large-mouthed black bass, *Micropterus salmoides*.....	390 m.m.	20-40 ft.	2	.012

Aside from the fishes taken in the trammel net at a depth exceeding 20 feet, and listed in Table No. 6, the lake whitefish, *Argyrosomus artedi cisco* and the ling, *Lota maculosa*, are known to occur in very deep water. During the summers of 1913 and 1914, dead lake whitefish were found. Each had an injury on the ventral side of the body, near the caudal fin. This injury resembled the scar made by the lake lamprey. Many other species of fish were taken, as will be seen later, with the same type of injury. At the close of the 1914 session of the Biological Station a large specimen of the ling, *Lota maculosa*, was found almost dead under a beached boat near the Station dock after a heavy wind storm. This species belongs to the deep water near the thermocline, at a depth varying from 35 to 40 feet or more.

In addition to the lake itself, Bessey Creek, the other smaller inlets and the outlet, Maple River, are important habitats for fishes. Bessey Creek is a sluggish stream varying from one to eight feet in depth. The bottom is covered with a deep layer of loose decayed vegetable matter and ooze. A considerable amount of high grass, rushes, *Scirpus americanus*, and white water lilies, *Castalia odoratum*, grow in the shallow water near the bank, and in many places in mid-stream. The banks are well wooded and shady. By frequent observations and seining it was found that the mud minnow, *Umbra limi*, is the dominant species of this habitat. The creek was seined several times and the combined data of the seinings are given below:

TABLE NO. 7.

	Species.	Number	Average size.	Frequency.	Place in stream.
1.	Mud minnow, *Umbra limi*....	190	85 m.m. (adults)	.626	Distributed over bottom.
2.	Yellow perch, *Perca flavescens*.	30	100 m.m. (young)	.099	Near surface, mid-stream.
3.	Blue gill, *Lepomis pallidus*....	18	60 m.m. (young)	.060	Mid-stream.
4.	Pumpkin seed, *Eupomotis gibbosus*.....	17	62 m.m.	.057	Mid-stream.
5.	Cayuga shiner, *Notropis cayuga*	13	25 m.m.	.043	Mid-stream.
6.	Rock bass, *Ambloplites rupestris*,	12	102 m.	.040	Mid-stream.
7.	Catfish, *Amierus melas*.....	8	142 m.m.	.026	At bottom of mid-stream.
8	Pickerel-pike, *Esox lucius*....	8	145 m.m. (young)	.026	Under grass along bank.
9.	Large-mouthed black bass, *Micropterus salmoides*.....	4	30 m.m. (young)	.014	Mid-stream.
10.	Sculpin, *Cottus ictalops*.....	1	48 m.m.	.004	Mid-stream.
11.	Iowa darter, *Etheostoma iowae*.	1	14 m.m.	.004	Mid-stream.

As shown by the table *Umbra limi* is by far the most frequent species in this habitat.

Maple River and the small streams coming into the lake, other than Bessey Creek, have been placed in the same group as regards type of habitat because they are more or less swift and clear, and offer about

GENERAL VIEW OF EAST SHORE OF SOUTH TWIN LAKE, LOOKING SOUTH FROM STATION 1

SOUTH TWIN LAKE, LOOKING NORTHWEST, SHOWING BROAD SHOAL WITH A SCANT RUSH GROWTH AND THE ZONES OF SHORE VEGETATION.

SOUTH TWIN LAKE, STATION 3, LOOKING NORTHWEST, SHOWING THE REGION FISHED AS FAR AS THE RUSHES EXTEND.

SOUTH TWIN LAKE, LOOKING NORTH, SHOWING AN UNUSUALLY BROAD BEACH BUT WITH MANY ENCROACHMENTS OF THE SMALL SHRUB ZONE.

SOUTH TWIN LAKE, STATION 13, LOOKING NORTH.

SOUTH TWIN LAKE, STATION 7, LOOKING EAST. FLOATING SPARGANIUM LEAVES NOT SHOWN ON ACCOUNT OF WAVES.

SOUTH TWIN LAKE, STATION 46, LOOKING NORTHWEST

SOUTH TWIN LAKE, STATION 40, LOOKING WEST. MOUTH OF MISERY CREEK.

the same sort of conditions. These stream beds are gravel or clear sand, and if a mucky bottom exists at all, it is near the banks or in holes and bayous along the stream. In these places the *Umbra limi* and small *Amieurus melas* are abundant. Aside from these situations, however, Maple River and the small clear streams afford a group of species different from those found in any other habitat of the region. The brook trout, *Salvelinus fontinalis*, is abundant along the small inlets and in Maple River five miles down stream from the lake. Besides *Salvelinus fontinalis*, several other species, which did not occur in the other habitats, were found in Maple River in abundance. *Etheostoma iowae*, *Notropis whipplii*, *Semotilus atromaculatus*, and *Rhinichthys atronasus* were taken in numbers. *Cottus ictalops* is also more abundant in Maple River than in Bessey Creek.

From the foregoing studies of the several habitats the fish fauna of Douglas Lake and connecting streams may be seen to include the following 26 species, of which 23 (marked *) occur in the lake proper:

TABLE NO. 8.

1. Bowfin, *Amia calva.**
2. Common sucker, *Catostomus commersonii.**
3. Catfish, *Amieurus melas.**
4. Hudson River shiner, *Notropis hudsonius.**
5. Common shiner, *Notropis cornutus.**
6. Cayuga shiner, *Notropis cayuga.**
7. Blue shiner, *Notropis whipplii.*
8. Horned dace, *Semotilus atromaculatus.*
9. Black-nosed dace, *Rhinichthys atronasus.*
10. Blunt-nosed minnow, *Pimephales notatus.**
11. Pickerel-pike, *Esox lucius.**
12. Mud minnow, *Umbra limi.**
13. Brook trout, *Salvelinus fontinalis.**
14. Lake whitefish, *Argyrosomus artedi cisco.**
15. Trout perch, *Percopsis guttatus.**
16. Log perch, *Percina caprodes.**
17. Iowa darter, *Etheostoma iowae.**
18. Johnny darter, *Boleosoma nigrum.**
19. Yellow perch, *Perca flavescens.**
20. Rock bass, *Ambloplites rupestris.**
21. Large-mouthed black bass, *Micropterus salmoides.**
22. Small-mouthed black bass, *Micropterus dolomieu.**
23. Pumpkin seed, *Eupomotis gibbosus.**
24. Blue gill, *Lepomis pallidus.**
25. Ling, *Lota maculosa.**
26. Sculpin, *Cottus ictalops.**

With this determination of the fish fauna of the Douglas Lake Region and the general distribution of the species in mind, the study of the mortality of the species was begun. To this end one mile of beach was laid off along the east side of South Fishtail Bay (See map, Fig. 2). This section of beach was chosen because it receives the full sweep of the wind from across the entire lake, hence most floating fish, even on the far side of the lake, are eventually beached somewhere within this mile. This strip of beach was gone over each evening and all of the beached fish collected, identified, measured, examined, and buried. The study of the beached fish was continued for a period of 40 consecutive days (July 10 to August 19, 1913), and was supplemented by a study of the beached fish on all shores of the lake. The following table gives the results of the 40 days collecting on the mile of beach:

TABLE NO. 9.

	Species.	Smallest.	Largest.	Size of majority of individuals.	Number injured.	Beached while feeding.	Other causes.	Total number beached.
1.	Yellow perch, *Perca flavescens*	25 m.m.	280 m.m.	100 m.m.	11	71	2,782	2,864
2.	Trout perch, *Percopsis guttatus*	30 m.m.	120 m.m.	80 m.m.	17		701	718
3.	Cayuga shiner, *Notropis cayuga*	30 m.m.	120 m.m.	70 m.m.	3		88	91
4.	Sucker, *Catostomus commersonii*	130 m.m.	400 m.m.	300 m.m.	1		55	56
5.	Rock bass, *Ambloplites rupestris*	70 m.m.	235 m.m.	140 m.m.	1		29	30
6.	Blue gill, *Lepomis pallidus*	60 m.m.	220 m.m.	90 m.m.	2		28	30
7.	Common shiner, *Notropis cornutus*	50 m.m.	105 m.m.	100 m.m.			19	19
8.	Hudson River shiner, *Notropis hudsonius*	30 m.m.	70 m.m.	60 m.m.	1		17	18
9.	Small-mouthed black bass, *Micropterus dolomieu*	120 m.m.	220 m.m.	140 m.m.		10		10
10.	Pumpkin seed, *Eupomotis gibbosus*	80 m.m.	130 m.m.	100 m.m.	1		9	10
11.	Catfish, *Amieurus melas*	150 m.m.	350 m.m.	200 m.m.			7	7
12.	Lake whitefish, *Aggyrosomus artedi cisco*	140 m.m.	210 m.m.	150 m.m.	3			3
13.	Log perch, *Percina caprodes*	80 m.m.	80 m.m.	80 m.m.	1			1
14.	Pickerel-pike, *Esox lucius*	165 m.m.	165 m.m.	165 m.m.	1			1
15.	Large-mouthed black bass, *Micropterus salmoides*	120 m.m.	120 m.m.	120 m.m.		1		1
	Total				42	82	3,735	3,859

In looking for the causes of death of the fish listed in Table 9, the following are at least to be considered: (1) mechanical injury, (2) injury through attacks of other species, (3) the beaching of individuals while pursuing or swallowing prey, (4) accidental beaching while attempting to escape enemies, (5) disease and parasites.

The total number of individuals of all species showing definite external injuries was low, something less than one-tenth of one per cent, and as may be seen in Table 9 these were distributed rather evenly among the several species in proportion to the total number beached. Many apparently normal fish, free from parasites and without any sign of injury, were beached which may have been killed by wave action either well out in the lake or at the edge of the shoal water where the high waves break.

Few if any specimens showed unmistakable injuries due to the attacks of other species. A few suckers bore circular wounds resembling lamprey marks but these wounds were of such a nature that they might have been due to any of several other causes.

In the "beached while feeding" column only those individuals were listed which were found with prey in the mouth. *Perca flavescens* was the heaviest loser in this way. Seventy-one beached specimens of this species had half-swallowed individuals of *Percopsis guttatus* in their mouths, and the Percopsidae in almost every case were adults. In addition to the specimens taken with prey in the mouth undoubtedly other individuals are beached while pursuing prey. *Catostomus commersonii*, a bottom feeder, is known to come into shallow water at night while feeding and individuals of this species might easily be beached by a sudden storm.

The beaching of small fishes while attempting to escape larger pursuing fishes was on more than one occasion observed. The young suckers, Notropi, and other young fishes are constantly preyed upon by the larger carnivorous species and schools of the small fish are often forced to the shore line by the pursuers. Here an incoming wave completes the beaching.

Parasites certainly play an important part in the death of a large number of the individuals reaching the beach. With very few exceptions all of the *Centrarchidae* beached, i. e. *Ambloplites rupestris*, *Lepomis pallidus* and *Eupomotis gibbosus* were infected in the gill chambers with parasitic Copepods. Often this infection was very heavy although some specimens bore but a few of the gill parasites. Many suckers and Cyprinids contained worm cysts in the body wall and in the skin. The parasitic worms were not examined, but Dr. La Rue (see report of the Director of the Biological Station for 1912) reports a variety of forms and a heavy infection of several species of fish.

It is understood that Table No. 9 does not give complete data on the death rate of the species of the lake but it is considered suggestive. In spite of the fact that many dead fish are eaten by water birds before reaching shore and that the fish successfully caught and eaten by other species can not be estimated, the data in Table 9 indicate a critical size in the life of several species of fishes. Those fishes about two-thirds grown (see table for length of majority of individuals) were most often beached. Again, as might be expected, the species most abundant in the lake proper were represented on the beach by the largest number of individuals. On the other hand those species found in the more restricted habitats were represented by fewer individuals, and those confined to streams by none.

In order that these data might be verified a trip was made covering the entire shore line of the lake of 15 miles in a single day. On this trip all beached fishes were measured, examined and identified. The data collected are given in Table 10.

TABLE NO. 10.

Including a study of the shores about the whole lake (Aug. 3, 1913).

Species.	Average size.	Number.
1. Small-mouthed black bass, *M. dolomieu*	240 m.m.	1
2. Large-mouthed black bass, *M. salmoides*	350 m.m.	1
3. Yellow perch, *Perca flavescens*	103 m.m.	551
4. Pumpkin seed, *Eupomotis gibbosus*	103 m.m.	1
5. *Notropus cayuga*	110 m.m.	2
6. Hudson River shiner, *Notropus hudsonius*	78 m.m.	10
7. Common shiner, *Notropus cornutus*	107 m.m.	7
8. Cat fish, *Amieurus melas*	204 m.m.	11
9. Common yellow sucker, *Catostomus commersonii*	290 m.m.	177
10. Rock bass, *Ambloplites rupestris*	132 m.m.	31
11. Log perch, *Percopsus guttatus*	97 m.m.	72
12. Pike-pickerel, *Esox lucius*	537 m.m.	5
13. Blue gill, *Lepomis pallidus*	98 m.m.	10
14. Lake whitefish, *A. a. cisco*	140 m.m.	2
Total		881

NOTE:—Several dead specimens of "Johnny darter" (*Boleosoma nigrum*) were observed lying among the pebbles in the shallows about Grape-vine Point and Fairy Island. Because of their lack of an air-bladder they are not thrown upon the beach as are the other species of dead fish but they remain in their habitat and are for the most part eaten by the crayfish.

The figures in Table 10 show the same relations of species as those in Table 9, the true lake forms being the ones most often beached.

In conclusion it may be said that *Perca flavescens, Percopsis guttatus, Catostomus commersonii* and *Notropis cayuga* were the forms most often beached.

The writer wishes to thank Dr. Max M. Ellis for suggestions and help in this work.

DRAGONFLIES OF THE DOUGLAS LAKE REGION, MICHIGAN.

ARTHUR T. EVANS

DRAGONFLIES OF THE DOUGLAS LAKE REGION, MICHIGAN[1].

ARTHUR T. EVANS

A partial list of the Odonata of the Douglas Lake Region (Cheboygan County, Michigan) was prepared by Miss Abigail O'Brien in 1910[2]. This report includes twenty-three species. An opportunity of listing the Odonata of this region more fully was afforded the writer during the summer of 1914 while at the University of Michigan Biological Station on Douglas Lake. The collections date from July 2 to August 21. During the course of the collecting as many individuals of each species were taken as possible. Forty-three species were secured.

The writer wishes to thank Professor Max M. Ellis for suggestions in the preparation of this report; Professor Frank Smith for specimens and records from Indian River; Professor T. D. A. Cockerell for the loan of several reprints; and also the many students at the Biological Station who were kind enough to furnish material for identification.

TOPOGRAPHY OF THE REGION.

The Douglas Lake Region with its small streams, lakes, marshes, and stagnant bogs, together with its forested, burned over, and open areas presents varied and suitable habitats for a number of species of Odonata. Specimens were taken from many habitats, both adults and nymphs being collected. Efforts were made to capture a number of adults which appeared new to the region. These efforts were unsuccessful in several cases, but the aquatic collections yielded nymphs of several species new to the region so that in all a fairly representative series of the Odonata species was secured. Collections were made from the following habitats.

Bessey Creek, one of the small streams flowing into Douglas Lake, forms a very desirable habitat for a number of species. This stream is of uniform width, averaging about fifteen feet. It has an average depth of about two and one-half feet, with a maximum depth of about five feet and a minimum depth of about one foot. For the most part the stream flows through a thickly wooded area with trees overhanging in many places while here and there are open areas. In many places

[1]Contribution No. 25 from the University of Michigan Biological Station.
[2]Rept. Mich. Acad. Sci., 1911, pp. 144-145.

vegetation is common in the stream. The bottom is of decayed vegetable matter with a thick cover of plant debris. The stream flows into the lake through a broad embayment which is well overgrown with reeds and flags.

Maple River, the only outlet to Douglas Lake, is in many ways very different from Bessey Creek. This stream does not flow through a wooded area but through a more open burned-over area. The stream is about twenty feet wide in its widest part and is on an average about two feet deep. Its current is swift but as it flows through a sandy country the water is very quiet. The bottom of this stream is of marl with some vegetation. About two miles from the lake, down the river, collections were made in a situation quite different from the river. The stream at this second station flows through an area from which the trees have been cut or burned as at its source, but the water is swifter and the bed of the stream is of coarse gravel and small rocks.

Bryant's Bog is a relic bog which has been cut off from the lake by the throwing up of a sand-bar. Although the whole bog occupies about ten acres only about one-half an acre is covered by open water. The water is about 18 feet in the shallowest part. The bog has no known outlet, although there is undoubtedly more or less loss of water through the very sandy, porous soil which surrounds it. The small size and great depth of this bog together with its location in a more or less sheltered place makes the water quiet. The dominant plant about the bog is *Chamaedaphne calyculata* (Linnaeus) the so-called "leather leaf." On account of its depth few plants grow from the bottom of the pool although the Chamaedaphne grows out into the water about the edge of the bog for several feet. This vegetation in the water makes an excellent habitat for a number of species which are abundant upon the submerged portions. Such species as *Tramea lacerata* Hagen and *Anax junius* Drury were found in numbers in this situation. The low shrubbery and a few large trees near this habitat supply a very desirable foraging ground for a number of the imagos.

Smith's Bog, located about two miles south of the Station, is another situation from which a number of specimens were obtained. The marshy area, although called a bog, is quite different from Bryant's Bog. It is located in an open area of about forty acres, the water covering about ten acres. In the water and about the edge of the bog for about one hundred feet is a thick growth of rushes of several species. There are a few trees standing, and over the whole area are old logs lying in or near the water. The depth of the water is probably not more than four or five feet in the deepest parts. Nymphs were found to be abundant in the water while the adults were also common.

Burt Lake, about one and one-half miles south of Douglas Lake, constitutes another of the habitats from which collections were made. On the north shore of this lake is Reese's Bog which is densely wooded and occupies an area of several hundred acres. This bog has no area completely inundated but the whole is more or less wet and there are several small outlet streams. The tamarack growth over the whole area is very dense with here and there narrow roads passing through it. Collections were made along the shore of the lake as well as along the roads leading through the bog.

North Fishtail Bay, a quiet and shallow little bay on the north shore of Douglas Lake, together with the pools and open areas in the adjoining woods, formed another of the situations collected from. A large number of both nymphs and adults were collected from this habitat.

From the shallow waters along the shore of the lake near camp and about the docks a number of species were secured which were not found elsewhere. Also the aspens near the Station were found to contain adults, some of which were seen nearly a mile from the water.

TAXONOMY.

Keys have been made for all species collected and all previously reported from the region, except those included in the difficult genus Enallagma Charpentier. Where a genus includes more than one species in the Douglas Lake Region, a key for the various species collected and previously reported is offered. Under the species head short discussions of the habitats, time of appearance, and abundance are given when the data were obtained. The nomenclature offered by Muttkowski[3] is followed. Free use has been made of certain other published reports on Odonata (see bibliography) to which the writer wishes to acknowledge his obligations.

KEY TO THE SUBORDERS AND FAMILIES OF THE ODONATA OF THE DOUGLAS LAKE REGION (MICHIGAN).

Imagos.

A. Front and hind wings similar in outline, spatulate and distinctly narrowed at the base, not held horizontally when at rest; head much wider than long; whole insect of a more or less frail appearance.

Suborder ZYGOPTERA

B. Wings rich black or dusky brown, or if hyaline with bright red or brown areas at the bases.

Family Agrionidae

BB. Wings hyaline—blush or transparent.

Family Coenagrionidae

[3]Bull. Public Mus. Milwaukee, I, 1910-1911, pp. 1-208.

AA. Front and hind wings dissimilar, held horizontally when at rest.
Suborder ANISOPTERA

C. Triangles of the front and hind wings similar, first and second series of anticubitals not coinciding, except the first and another thick one.
Family Aeshnidae

CC. Triangles of the front wings, with the long axis of the triangle at right angles to the long axis of the wings; triangles of the hind wings with the long axis coinciding with the axis of the wing.
Family Libellulidae

Nymphs.

A. Last abdominal segment with terminal, leaf-like gills.
Suborder ZYGOPTERA

B. Basal segment of the antennae much elongated.
Family Agrionidae

BB. Basal segment of the antennae short.
Family Coenagrionidae

AA. Last abdominal segment ending in five, short, spine-like appendages.
Suborder ANISOPTERA

C. Labium flat, not concealing the front of the head.
Family Aeshnidae

CC. Labium spoon-shaped, covering most of the front part of the head.
Family Libellulidae

FAMILY AGRIONIDAE.

KEY TO THE GENERA OF AGRIONIDAE.

Imagos.

A. Imagos with wings of a rich black or dusky brown color; basal spaces in all of the wings without cross veins.
Agrion

AA. Imagos with large red or brown areas at the bases of the wings, if the wings are hyaline, basal spaces with cross veins.
Hetaerina

Nymphs.

A. Median cleft of the median labial lobe extending far below the base of the lateral labial lobes.
Agrion

AA. Median cleft of the median labial lobe not extending below the base of the lateral labial lobes.
Hetaerina

GENUS *AGRION* FABRICIUS.

Imagos.

A. Apical third of the hind wings black or cloudy.
A. aequabile

AA. Wings uniformly black or smoky brown.
A. maculatum

Nymphs.

A. Basal segments of the antennae one-third longer than the head is wide.
A. aequabile

AA. Basal segment of the antennae equal to or less than the width of the head.
A. maculatum

Agrion aequabile (Say). Pl. IX, Fig. B.—Adults and nymphs of this species were taken on Bessey Creek, and at the station on Maple River, about two miles down stream from the source. Although a number of both adults and nymphs were taken in both situations the adults were rather uncommon on Maple River. The nymphs in general were found clinging to the vegetation in the stream, seeming to prefer the swifter parts.

Agrion maculatum Beauvois. Pl. IX, Fig. D.—This species was taken in both the adult and nymph stages in the same situations as *Agrion aequabile*. The adult with its handsome black or smoky wings is easily distinguished when once seen, while the nymph with its sprawling legs is easily recognized.

GENUS *HETAERINA* HAGEN.

Hetaerina americana Fabricius. Pl. IX, Fig. A.—None of the nymphs of this beautiful dragonfly were collected but adults were taken by Dr. Max M. Ellis at the station some distance down Maple River. The brilliant red at the bases of the wings of the males and the pale brown at the bases of the wings of the females will distinguish this species at once.

FAMILY COENAGRIONIDAE.

KEY TO THE SUBFAMILIES OF COENAGRIONIDAE.

Imagos.

A. Vein M_3 arising from vein M_{1+2} nearer the arculus than the nodus.
Subfamily Lestinae

AA. Vein M_3 arising from vein M_{1+2} nearer the nodus than the arculus.
Subfamily Coenagrioninae

Nymphs.

A. Lateral labial lobes trifid at the distal end, movable hook of the labium bearing raptorial setae.
Subfamily Lestinae

AA. Lateral labial lobes bifid at the distal end, movable hooks of the labium without raptorial setae.
Subfamily Coenagrioninae

SUBFAMILY LESTINAE.

A single genus, Lestes, is known from the subfamily Lestinae at Douglas Lake. Since the females of the genus are so very much alike no key has been made to distinguish them, the following key being only for the determination of the males. Also no key has been made for the determination of the nymphs as their great similarity makes identifica-

tion very difficult. It might be well to state that *L. forcipata* and *L. rectangularis* have either five or six raptorial setae while *L. unguiculata* and *L. uncata* normally have seven setae. There seems to be no very definite way to distinguish between each of the two species which have been thus separated. The nymph of *L. disjuncta*, the only other species of Lestes known from Douglas Lake, is unknown.

GENUS *LESTES* LEACH.

Imagos.

A. Males metallic green.
  B. Inferior appendages of the male viewed from above exhibiting a sigmoid curve. *L. unguiculatus*
  BB. Inferior appendages of the male viewed from above strongly dilated at the apex. *L. uncatus*
AA. Males blackish brown.
  C. Apex of the inferior appendages of the male declined. *L. rectangularis*
  CC. Apex of the inferior appendages not declined.
    D. Inferior appendages of the male viewed from above slightly widened at the tip: proximal tooth on the inner edge of the superior appendage larger than the other. *L. forcipatus*
    DD. Inferior appendages of the male not widened at the tip; the two teeth on the superior appendage about equal. *L. disjunctus*

Lestes rectangularis Say.—A number of adults of this species were taken both from the beach pool, which is located west of North Fishtail Bay, and from Smith's Bog. Nymphs taken from the same habitat as the adults were identified as *L. rectangularis* although they are very similar to *L. forcipata* Rambur.

Lestes forcipatus Rambur.—This species was taken by Miss Abigail O'Brien during the summer of 1910. She reports that a number of adults were taken on August 19 but does not state the locality from which they were secured. No adults were taken in the collections upon which the present report is based, and since the nymphs of this species are so much like those of *L. rectangularis* they were not determined.

Lestes unguiculatus Hagen.—One adult of this species and a number of nymphs were taken on Maple River. The nymphs of this species are very similar to those of *L. uncatus* Kirby.

Lestes uncatus Kirby.—Neither adults nor nymphs were referred to this species although it is possible that some of the nymphs identified as *L. unguiculatus* may be *L. uncatus*. A number of adults were collected by Miss O'Brien in 1910.

Lestes disjunctus Selys.—This species was not taken at Douglas Lake in 1914 but were reported as common in 1910.

SUBFAMILY COENAGRIONINAE

KEY TO THE GENERA OF COENAGRIONINAE.

Imagos.

A. No postocular spots; dorsum bronzy green.
Nehalennia

AA. Light, round or ovoid, postocular spots.

B. Sexes unlike in color, female with the orange of the abdomen covering less than the three basal segments of the abdomen; males chiefly black or green with a bifid process on the apical margin of the 10th abdominal segment; pterostigma rhomboidal.
Ischnura

BB. Color of the males and females similar, females somewhat lighter; no upturned bifid process on the apical margin of the 10th abdominal segment.
Enallagma

Nymphs.

A. Labium with one mental setae and a rudimentary second one; antennae six jointed.
Nehalennia

AA. Labium with three to five mental setae; antennae seven jointed.

B. Labium with four to six lateral setae; usually three mental setae on each side.
Enallagma

BB. Labium with five or six lateral setae; four mental setae.
Ischnura

GENUS *NEHALENNIA* SELYS.

Nehalennia irene Hagen.—This species was not taken in any of the collections at Douglas Lake during the summer of 1914 but was reported as common during July and August, 1910.

GENUS *ENALLAGMA* CHARPENTIER.

Two species of this genus, the males of which may be distinguished by the following key, are known from the Douglas Lake region.

Imagos.

A. Dorsum of segment two blue with an apical black spot.
E. carunculatum

AA. Dorsum of segment two black.
E. exulans

Enallagma carunculatum Morse.—This species was reported to be common in the region throughout the summer of 1910. No habitat data were given.

Enallagma exulans Hagen.—Specimens of these nymphs were taken on Maple River. They were found clinging to the vegetation near shore in very little water. The species has also been found in the water of North Fishtail Bay.

GENUS *ISCHNURA* CHARPENTIER.

Imagos.

A. Segments eight and nine of the abdomen blue with a black stripe on each side.
I. verticalis

AA. Segments eight and nine of the abdomen black.
I. posita

Nymphs.

A. Labium with six lateral setae on each side.
I. verticalis

AA. Labium with five lateral setae on each side.
I. posita

Ischnura verticalis (Say).—This species was taken from the swifter water of the station about two miles down Maple River.

Ischnura posita (Hagen).—This species was taken from the same habitat as *I. verticalis.*

FAMILY AESHNIDAE.

This family is represented in the Douglas Lake region by two subfamilies.

Imagos.

A. Eyes distinctly separated above on the middle of the head.
Subfamily Gomphinae

AA. Eyes meeting above in the middle line of the head.
Subfamily Aeshninae

Nymphs.

A. Antennae four jointed, broad and flat; superior appendage not notched at the apex.
Subfamily Gomphinae

AA. Antennae six or seven jointed; superior appendage notched at the apex.
Subfamily Aeshninae

SUBFAMILY GOMPHINAE.

Imagos.

A. Both triangles with a cross vein.
Gomphoides

AA. Both triangles without a cross vein, (except the discoidal triangle in Hagenius).

B. First and second anal veins angulated toward each other at the cross vein of the anal loop, which contains from three to five cells.

C. Discoidal triangle without cross veins; anal loop three celled.
Ophiogomphus

CC. Discoidal triangle four sided, with cross veins; anal loop three to five, usually four celled.
Hagenius

BB. First and second anal veins nearly parallel; anal loop one or two celled.

D. Hind femora with five to seven long spines in addition to the usual short ones.
Dromogomphus

DD. Hind femora with the usual short spines but with no long ones.
Gomphus

Nymphs.

A. Middle legs closer together at the base than the fore ones; inner wing cases strongly divergent.
Gomphoides

AA. Middle legs as far apart as the fore ones.
B. Inner wing cases strongly divergent.
Ophiogomphus

BB. Inner wing cases parallel.
C. Third antennal joint flat, subcylindrical or broadly oval; body broad and flat.
Hagenius

CC. Third antenna: joint subcylindrical, more than twice as long as thick.
D. Dorsal hooks short but with acute spiny tips.
Dromogomphus

DD. Dorsal hooks sometimes present, but obtusely pointed, usually absent excepting a median tooth on the ninth segment.
Gomphus

GENUS *GOMPHOIDES* SELYS.

Gomphoides obscurus (Rambur).—The nymphs of this species were taken at the station on Maple River about two miles below the source. They seem to prefer the swifter parts of the stream, clinging to and crawling over the vegetation and rocks.

GENUS *HAGENIUS* SELYS.

Hagenius brevistylus Selys. Pl. IX, Fig. F.; Pl. X, Figs. B, D.—Nymphs of this queerly designed species were taken many times during the summer. They were found in Maple River, Bessey Creek and in the beach pool near North Fishtail. The nymphs were taken from the first layers of ooze along the bottom. No adults were taken.

GENUS *OPHIOGOMPHUS* SELYS.

Ophiogomphus carolus Needham.—Nymphs of this species were found only in Maple River. Like those of *Gomphoides obscurus* they were found in the relatively swift water on submerged vegetation, logs and rocks. No adults were taken.

GENUS *GOMPHUS* LEACH.

Imagos.

A. Face entirely yellow.
B. Tibia yellow externally; posterior abdominal segments not dilated.
G. spicatus

BB. Tibia black externally.
C. Posterior end of the abdomen dilated.
G. ventricosus

CC. Posterior end of the abdomen not dilated.
G. descriptus

AA. Face transversely banded with black.
D. Yellow of the thoracic dorsum reduced to two narrow, oblique, isolated, yellow stripes.
G. scudderi
DD. Yellow stripes of the thoracic dorsum broader; anterior face of the hind femora yellow.
G. vastus

Nymphs.

In the following key *Gomphus ventricosus* is not included since the nymph of that species is unknown.

A. Four pairs of lateral spines.
B. Dorsal hooks more or less apparent on segments two or three to nine.
G. descriptus
BB. Dorsal hooks represented only by teeth on the posterior margins of eight and nine.
CC. Lateral spines on nine about as long as the tenth segment.
G. vastus
CC. Lateral spines on the ninth segment about half as long as segment ten.
G. scudderi
AA. Three pairs of lateral spines, the first pair very small.
G. spicatus

Gomphus spicatus Hagen.—Nymphs of this species were taken in Maple River near its source. Their habitat is probably the stream vegetation. No adults were taken.

Gomphus ventricosus Walsh.—This species was reported from the region in 1910 but did not occur in any of the 1914 collections.

Gomphus descriptus Banks.—Only the nymphs of this species were taken at one station on Maple River.

Gomphus scudderi Selys.—This species was not taken in 1914 although adults were reported from the region in 1910.

Gomphus vastus Walsh.—Nymphs of this species were taken in Bessey Creek where they seemed to prefer the bottom of the stream and the lower parts of the vegetation.

SUBFAMILY AESHNINAE.

Large numbers of nymphs representing six of the eight species of this subfamily found in the Douglas Lake region were collected, but the adults of only four species were taken. These species *Epiaeschna heros* (Fabricius), *Basiaeschna janata* (Say), *Aeshna constricta* Say and *Anax junius* Drury were very common.

Imagos.

A. Upper part of the arculus equal to or longer than the lower part; anal loop five to seven sided.
B. Radial sector forked.
C. Radial sector forked near the middle.
Epiaeschna
CC. Radial sector forked beyond, *i. e.* apicad to the middle.
Aeshna

BB. Radial sector not forked.
D. Space between the arculus and the base of the wing crossed by from two to six cross veins; anal triangle, in the male, three to five celled.
Boyeria
DD. Space between the arculus and the base of the wing free or crossed by but a single cross vein.
Basiaeschna
AA. Upper part of the arculus shorter than the lower; the upper sector rising about midway between the lower sector and the median vein above.
Anax

Nymphs.

A. Five pairs of lateral spines.
B. Antennae six jointed.
Epiaeschna
BB. Antennae seven jointed.
C. Lateral labial lobes scarcely tapering, subtruncate at the tip.
Boyeria
CC. Lateral labial lobes tapering to an incurved tooth.
Basiaeschna
AA. Three or four pairs of lateral spines.
D. Four pairs of lateral spines, the anterior pair small.
Aeshna
DD. Three pairs of well developed spines.
Anax

GENUS *EPIAESCHNA* HAGEN.

Epiaeschna heros (Fabricius).—Adults of this large species were common throughout the summer in various habitats. These dragonflies were found along Maple River and Bessey Creek, about the bogs, over the lake, about a mile from shore, and back in the aspens a mile or more from water. One specimen was taken about seven-thirty P. M., in the late twilight, as it was flying swiftly about one of the roads through Reese's Bog. Adults of this species were especially abundant in the vicinity of Smith's Bog.

GENUS *BOYERIA* MACLACHLAN.

Boyeria vinosa (Say).—The nymphs of this species were taken in numbers from the submerged vegetation at Bryant's Bog. No adults were captured.

GENUS *BASIAESCHNA* SELYS.

Basiaeschna janata (Say).—The nymphs of this dragonfly were found on vegetation in Bessey Creek and the adults were caught along both Maple River and Bessey Creek.

GENUS *AESHNA* FABRICIUS.

Imagos

A. Anal triangle of the hind wing of the male usually consisting of three cells; genital valve of the female strongly elevated at the apex.
A. constricta

AA. Anal triangle of the hind wing of the male usually consisting of two cells; genital valve of the female not strongly elevated at the apex.
B. A black line on the fronto-nasal suture; hamular processes short and broad.
A. interrupta
BB. No black line on the fronto-nasal suture.
A. canadensis

Nymphs.

A. Mentum of the labium distinctly more than half as broad at the base as at the apex.
B. Lateral labial lobes squarely truncate, the outer apical angle scarcely rounded.
A. interrupta
BB. Lateral labial lobes not truncate, but curving to a prominent, apical hook.
A canadensis
AA. Mentum of the labium not, or scarcely, half as broad at the base as at the apex.
A. constricta

Aeshna constricta Say.—Nymphs of this species were taken in Bessey Creek and Bryant's Bog. Prof. Frank Smith also collected several specimens in Indian River, the outlet, at the extreme southern end of Burt Lake about nine miles from my Burt Lake station.

Aeshna interrupta Walker.—This species was reported from Douglas Lake in 1910, one specimen being taken on August 18.

Aeshna canadensis Walker.—This species was reported common to the region during the summer of 1910. Neither nymphs or adults were taken during the summer of 1910.

GENUS *ANAX* LEACH.

Anax junius (Drury). Pl. IX, Fig. E.; Pl. X, Figs. E, F.—Both adults and nymphs of this dragonfly were common all summer. Nymphs were taken from the submerged vegetation at Smith's Bog, Bryant's Bog and the beach pool near North Fishtail Bay, usually in water which was relatively quiet. The adults of the species were taken in various situations about the water as well as in the aspens near the lake.

GENUS *DROMOGOMPHUS* SELYS.

Dromogomphus spinosus Selys.—One specimen of this species, undergoing exuviation, was taken on the dock near camp.

FAMILY LIBELLULIDAE.

KEY TO THE SUBFAMILIES OF LIBELLULIDAE.

Imagos.

A. Sectors of the arculus distinctly separated.
Subfamily Cordulinae
AA. Sectors of the arculus in close proximity or completely fused for a short distance from the arculus.
Subfamily Libellulinae

Nymphs.

A. Lateral abdominal appendages more than half as long as the inferiors; hind femora longer than the head is wide.
Subfamily Cordulinae

AA. Lateral abdominal appendages less than half the length of the inferiors; hind femora generally as long as the head is wide.
Subfamily Libellulinae

Subfamily Corduliinae.

KEY TO THE GENERA OF CORDULINAE.

Imagos.

A. Triangle of the hind wing placed considerably beyond the arculus.
Macromia

AA. Triangle of the hind wing retracted to the level of the arculus or even passing it.
B. Triangle of the hind wing with a cross vein.
Epicordulia

BB. Triangle of the hind wing without a cross vein.
C. Wings with black basal markings.
Tetragoneuria

CC. Wings clear.
Cordulia

Nymphs.

A. Head with a prominent, pyramidal horn.
Macromia

AA. Head without a prominent, pyramidal horn.
B. Lateral setae four or five.
Epicordulia

BB. Lateral setae seven.
C. Abdomen with large dorsal hooks.
Tetragoneuria

CC. Abdomen without dorsal hooks.
Cordulia

GENUS *MACROMIA* RAMBUR.

Macromia illinoiensis Walsh. Pl. IX, Fig. C; Pl. X, Fig. A.—This spider-like nymph was only taken twice, once on Maple River and once in the shallow water along the lake shore near camp. The nymphs taken on Maple River were from vegetation along the shore but the specimens taken at camp (these may have been wave-washed individuals) were found on the piles of the dock. No adults were taken.

GENUS *EPICORDULIA* SELYS.

Epicordulia princeps (Hagen).—This species was found to be rather rare, only a few nymphs occurring in the collections from Maple River.

GENUS *TETRAGONEURIA* HAGEN.

Tetragoneuria spinosa (Hagen).—Nymphs of this species were taken in Maple River, Bryant's Bog, and the beach pool west of North Fish-

tail Bay. They were found among the submerged vegetation in fairly deep water. No adults were secured. The eggs of this species, which are laid in strings, were found attached to aquatic vegetation both in North Fishtail Bay and at the mouth of Bessey Creek.

GENUS *CORDULIA* LEACH.

Cordulia shurtleffi Scudder.—Nymphs of this species were taken in Bessey Creek although they appear to be rather uncommon, judging from the number appearing in the collections. These nymphs were found along the shore in debris of various sorts.

Subfamily Libellulinae.

KEY TO THE GENERA OF LIBELLULINAE.

Imagos.

A. Triangle of the fore wing not placed distinctly beyond the level of the apex of the triangle of the hind wing; ends of pterostigma not distinctly divergent.
  B. Sectors of the arculus, veins M_1 to 3 and M_4, in the fore wing more or less completely fused for a short distance beyond the arculus; triangle of the fore wing not greatly produced posteriorly, normally containing but a single cross-vein.
    C. Vein Cu_1 of the hind wing departing from the triangle at the hind angle.
      D. Sectors of the arculus contiguous but incompletely fused for a distance beyond the arculus; wings generally spotted with yellow or reddish brown.
        Celithemis
      DD. Sectors of the hind wing distinctly fused for a distance beyond the arculus.
        Sympetrum
    CC. Vein Cu_1 of the hind wing migrating a little way up the outer side of the triangle.
      Pachydiplax
  BB. Sectors of the arculus of the fore wing contiguous but not completely fused beyond the point of their departure from the arculus.
    Libellula
AA. Triangle of the fore wing placed distinctly beyond the level of the apex of the triangle of the hind wing.
  Tramea

Nymphs.

A. Basal segment of the hind tarsus more than half as long as the second segment.
  B. No dorsal hooks.
    Pachydiplax
  BB. With dorsal hooks at least on the middle abdominal segments.
    C. Abdomen ovate.
      D. Lateral spines long and straight.
        Celithemis
      DD. Lateral spines short and more or less incurved.
        Sympetrum
    CC. Abdomen lanceolate; five to ten lateral setae
      Libellula
AA. Basal segment of the hind tarsus only half as long as the second segment; lateral setae ten or more.
  Tramea

GENUS *CELITHEMIS* HAGEN.

Celithemis eponina (Drury).—Nymphs of this species were collected in the aquatic vegetation in Bessey Creek. Their frequent appearance in collections from Bessey Creek marks the species as a rather common form. No adults were taken.

GENUS *SYMPETRUM* NEWMAN.

Imagos.

A. Superior appendages of the male with a prominent, inferior, median tooth; vulvar lamina of the female divided by a median cleft into two lobes.
  B. Wings with the basal half flavescent.
    S. assimilatum
  BB. Wings flavescent only at the extreme base, or at least not beyond the nodus.
    C. Branches of the genital hamules of the male enclosing an oval notch, outer branch twice as stout as the inner, both equally curved.
      D. Median inferior tooth of the superior male appendages bearing two or three minute teeth and preceded by four large coarse teeth; inferior appendage of the male with a terminal recurved hook.
        S. scoticum
      DD. Median inferior tooth of the superior male appendages simple, and preceded by three coarse teeth; terminal hook of the inferior appendage not recurved.
        S. rubicundulum
    CC. Branches of the genital hamules of the male enclosing a short rounded notch, the inner branch more sharply incurved, the outer branch about four times as thick as the inner.
      S. obtrusum
AA. Superior appendages of the male without a prominent, inferior, median tooth, but with several small, interior, subequal, pointed denticles, wings flavescent only at the base.
  S. costiferum

Nymphs.

A. Dorsal hooks of abdominal segments six to eight long and sharp, about as long as their respective segments; lateral spines straight.
  S. costiferum
AA. Dorsal hook of abdominal segments six to eight shorter than the segments bearing them and less pointed than in the preceeding species.
  S. assimilatum
  S. rubicundulum
  S. obtrusum

Owing to the incompleteness of the knowledge of the nymphs in this genus the above key gives the diagnostic characters of but one species. No description of the nymph of *S. scoticum* (Donovan) was found.

Sympetrum assimilatum (Uhler).—Reported from the region in 1910, a male and female being taken *in coitu*, as well as a number of other specimens.

Sympetrum rubiundulum (Say).—This species was common near North Fishtail Bay and at Smith's Bog. Adults were abundant in a little relic bog near North Fishtail. Nymphs were taken in numbers from Bessey Creek, the North Fishtail beach pool and at Smith's Bog.

Sympetrum scoticum (Donovan).—Reported on August 11, 1910. No habitat data given.

Sympetrum obstrusum (Hagen).—This species was reported as common in the region from July 23 to August 20, 1910. No habitat data were given. It was not included in the 1914 collections.

Sympetrum costiferum (Hagen).—Reported in 1910.

GENUS *PACHYDIPLAX* BRAUER.

Pachydiplax longipennis (Burmeister).—One nymph of this species was collected about two miles down stream from the lake in Maple River, where it was found among trash and vegetation along the shore.

GENUS *LIBELLULA* LINNE.

KEY TO THE SPECIES OF LIBELLULA.

Imagos.

A. Wings with no nodal spots.
L. cyanea

AA. Wings with large nodal spots.
L. pulchella

Nymphs.

A. Dorsal hooks on the seventh and eight abdominal segments long and sharp; lateral setae six.
L. cyanea

AA. Dorsal hooks on the seventh and eighth abdominal segments rudimentary; lateral setae eight or nine.
L. pulchella

Libellula cyanea Fabricius.—The nymphs of this species were collected at the station on Maple River about two miles down from the lake. They were taken among trash along shore.

Libellula pulchella Drury.—This species was taken in both the nymph and the adult stages. They were found common about North Fishtail Bay as well as on Maple River. The nymphs were taken in trashy situations along the shore; the adults flying about near the shore.

GENUS *TRAMEA* HAGEN.

Tramea lacerata Hagen.—Nymphs of this species were among the most common forms collected. A single dip of the net through the submerged vegetation in Bryant's Bog would usually yield twenty or more of the nymphs. The nymphs were also found in both Smith's and Reese's Bogs. Although large numbers of nymphs were collected no adults were obtained.

DISCUSSION AND SUMMARY.

The suborder *Anisoptera,* which contains some of the largest and most handsome dragonflies, includes the majority of species of Odonata at present known from the Douglas Lake Region. (See Table 1). Of the forty-three species which have been collected in the region thirty are Anisoptera. The nymphs of the *Anisoptera* occupy every type of habitat suitable for Odonata from the stagnant bog to the swiftly flowing streams, and adults of this group were found flying about through the aspens a mile or more from water as well as some distance from the shore over the lake. In general the adults of *Anisoptera* are very alert and so active on the wing that their capture in many cases is almost impossible. On the other hand, however, in certain places which were infrequently visited, as Smith's Bog, the adults seemed less shy and were easily captured as they hovered before one.

TABLE 1.—SUMMARY OF SPECIES.

Suborder ZYGOPTERA	13		
I. Agrionidae		5	
1. *Agrion*			2
2. *Hetaerina*			1
II. Ceonagrionidae		10	
3. *Lestes*			5
4. *Nehalennia*			1
5. *Ischnura*			2
6. *Enallagma*			2
Suborder ANISOPTERA	30		
III. Aeschnidae		16	
7. *Gomphoides*			1
8. *Hagenius*			1
9. *Ophiogomphus*			1
10. *Gomphus*			5
11. *Epiaeschna*			1
12. *Boyeria*			1
13. *Basiaeschna*			1
14. *Aeshna*			3
15. *Anax*			1
16. *Dromogomphus*			1
IV. Libellulidae		14	
17. *Macromia*			1
18. *Epicordulia*			1
19. *Tetragoneuria*			1
20. *Cordulia*			1
21. *Celithemis*			1
22. *Sympetrum*			5
23. *Pachydiplax*			1
24. *Libellula*			2
25. *Tramea*			1
Total			43

In connection with the above table it is interesting to note that the forty-three species listed represent a rather rich Odonata fauna for the region studied, since Williamson[4] records but eighty-three species (forty-three Zygoptera and forty Anisoptera) from the entire state of

[4]Rept. Ind. Dept. Geol. Nat. Resources, 1900, p. 233.

Indiana and Muttkowski[5] records four hundred ninety-four species and subspecies from North America.

The data gathered, coming from varied habitats as they do, make possible an ecological study of the nymphs. These habitat relations have been incorporated in Table 2.

TABLE 2.—HABITAT PREFERENCES OF THE NYMPHS COLLECTED.

Species.	Vegetation.	No vegetation.	Bottom.		Water.		
			Muck.	Sand.	Rapid.	Slow.	Still.
ZYGOPTERA							
Agrion maculatum	x		x		x		x
Agrion aequabile	x		x		x		x
Hetaerina americana	x	x		x	x		x
Lestes rectangularis	x						x
Lestes unguiculata	x						x
Lestes disjuncta							
Lestes uncata							
Lestes forcipatus							
Enallagma carunculatum	x					x	x
Enallagma exulans							
Ischnura posita	x	x		x	x	x	
Ischnura verticalis	x	x		x	x	x	
Nehalennia irene							
ANISOPTERA							
Gomphoides obscurus		x	x	x	x	x	
Hagenius brevistylus		x	x	x	x	x	
Ophiogomphus carolus		x	x	x	x	x	
Gomphus ventricosus							
Gomphus spicatus	x	x	x		x		
Gomphus vastus	x	x	x	x		x	x
Gomphus descriptus	x	x	x	x	x	x	
Gomphus scudderi							
Epiaeschna heros	x		x		x		
Boyeria vinosa	x						x
Basiaeschna janata	x		x			x	x
Aeshna constricta	x		x	x		x	x
Aeshna canadensis							
Aeshna interrupta							
Anax junius	x					x	x
Dromogomphus spinosus		x	x	x	x	x	
Macromia illinoiensis		x	x	x		x	
Epicordulia princeps	x	x	x		x		
Tetragoneuria spinosa	x	x	x		x	x	x
Cordulia shurtleffi	x	x	x			x	
Celithemis eponina	x	x	x			x	x
Sympetrum rubicundulum	x	x	x		x	x	
Sympetrum assimilatum							
Sympetrum obtrusum							
Sympetrum costiferum							
Sympetrum scoticum							
Pachydiplax longipennis	x	x	x	x	x	x	
Libellula pulchella	x	x	x	x		x	x
Libellula cyanea	x	x	x	x		x	
Tramea lacerata	x	x	x				x
	25	20	22	14	15	20	16

It is to be noted that this table lacks data for twelve species which are known from the Douglas Lake Region.

Table 2 shows rather well the vertical distribution within the habitats and the habitat preferences. In general it may be said that the *Aesh-*

[5]Bull. Public Mus. Milwaukee, I, 1910-11, p. 6.

ninae are found almost entirely in and on the submerged aquatic vegetation or on objects not covered with mud. The nymphs were almost without exception clean, brightly colored and active. The *Gomphinae*, on the other hand, were usually found in numbers on a mud bottom in the top layers of the ooze. Specimens were, however, occasionally captured on vegetation, logs or other floating objects, a fact which might be explained as a preparation for the moulting attendant to transformation. Gomphid nymphs were almost always dully colored and more or less incrusted with mud and algae. The Libellulids were usually found in the trash and debris on the bottom of the stream or among the lower parts of the vegetation. Their preference for such situations is also shown by the large number of mud-incrusted specimens of this group collected. Some species of this family, for example, *Tramea lacerata*, were taken in water less than two feet deep at Bryant's Bog. The great depth of the water in the center of this bog, where it exceeds twenty-five feet, may account for these nymphs being nearer to the surface, clinging to the aquatic vegetation.

Without exception the Zygoptera of the region were found in aquatic vegetation rather near the surface of the water. The nymphs of some species, for example *Agrion aequabile*, frequent the swiftest parts of small streams. The preference of the *Zygoptera* nymphs for surface situations or rapidly moving streams may be a corollary of the oxygen relations. In this connection it was observed that the Gomphid nymphs have a very characteristic way of holding the posterior end of the abdomen turned up at a very decided angle. This habit, together with their mud-burrowing habit and the length of the tenth abdominal segment, which segment in many cases is much longer than the ninth segment, might be interpreted as an adaptation for securing a better supply of oxygen. The top layers of ooze through which the nymphs crawl generally contain decaying animal and vegetable matter from which more or less carbon dioxide is discharged; thus a nymph would be able to get more water and hence more oxygen if the end of the abdomen could be extended upward above the ooze.

University of Colorado,
October 24, 1914.

BIBLIOGRAPHY.

Muttkowski, R. A., Catalogue of the Odonata of North America, Bull. Public Mus. City of Milwaukee, Vol. I, pp. 1-208, 1910-11.

Needham, J. G., and Hart, C. A., The Dragonflies (Odonata) of Illinois, Pt. I, Bull. Ill. State Lab. Nat. Hist., Vol. VI, Art. I, pp, 1-94, 1901.

Needham, J. G., Aquatic Insects in the Adirondacks, Bull. 47, N. Y. State Mus., pp, 383-591, 1901.

Needham, J. G., Aquatic Insects in New York State, Bull. 68, N. Y. State Mus., pp, 199-501, 1903.

O'Brien, Abigail, Odonata Collected at Douglas Lake, Michigan, in the Summer of 1910, Rept. Mich. Acad. Sci., for 1910, pp. 144-145, 1911.

Walker, E. M., The North American Dragonflies of the Genus Aeshna, Uni. Toronto Studies, Biol. Ser. No. 11, 1912.

Williamson, E. B., Dragonflies of Indiana, Rept. Ind. Dept. Geol. Nat. Resources, for 1899, pp. 229-333, 1900.

Idem, Notes on a Few Wyoming Dragonflies, Ent. News, Vol. XI, No. 5, p. 457, 1900.

A.

B.

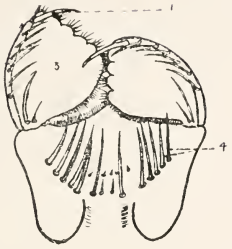
C.

D.

E.

F.

FIGURE A. ADULT OF *HETAERINA AMERICANA* (FABRICIUS)
FIGURE B. ADULT OF *AGRION AEQUABILE* (SAY)
FIGURE C. NYMPH OF *MACROMIA ILLINOIENSIS* WALSH
FIGURE D. ADULT OF *AGRION MACULATUM* BEAUVAIS
FIGURE E. ADULT OF *ANAX JUNIUS* (DRURY).
FIGURE F. NYMPH OF *HAGENIUS BREVISTYLUS* SELYS

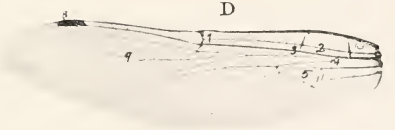


A

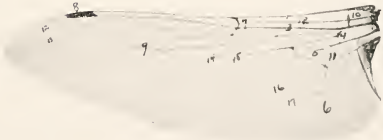
B

D

C



E



F

FIGURE A. LABIUM OF A NYMPH OF *MACROMIA ILLINOIENSIS* WALSH.
FIGURE B. FIGURE OF *HAGENIUS BREVISTYLUS* SELYS.
FIGURE C, FIGURE OF THE LABIUM OF *AGRION AEQUABILE* (SAY).
FIGURE D, SIDE VIEW OF THE ABDOMEN OF *HAGENIUS BREVISTYLUS* SELYS.
FIGURES E AND F, FORE AND HIND WINGS OF *ANAX JUNIUS* (DRURY).

THE REPTILES AND AMPHIBIANS OF MONROE COUNTY, MICHIGAN.

CRYSTAL THOMPSON.

THE REPTILES AND AMPHIBIANS OF MONROE COUNTY, MICHIGAN.

CRYSTAL THOMPSON.

An expedition was sent by the Michigan Biological Survey into Monroe County during the summer of 1913 to determine the reptile-amphibian fauna of the county and to gather additional data on these groups in the southeastern part of the state.

Monroe County lies in the extreme southeastern corner of Michigan and is bordered entirely on the east by Lake Erie—which forms the outlet for the drainage system. The county as a whole is a flat plain sloping very gently to the southeast, the principal stream being the River Raisin which flows in a generally southeasterly direction and empties into the lake about 4 miles east of the city of Monroe.

Collecting was first carried on along the shores of Lake Erie, in the vicinity of Monroe Piers, and later in the summer along the river about four miles west of the city of Monroe. At Monroe Piers there is a narrow strip of sand beach back of which are hundreds of acres of overflowed marsh land. This strip of beach is partly covered with vegetation, there are a few large trees and the whole is over-run with wild grape vines. The water averages perhaps three or four feet in depth in the marshes, which are grown up with water plants. Occasionally throughout the marshes are small areas of higher land, and the bed of an electric line running out to the Piers forms a strip of dryer ground.

The region worked above Monroe is a thickly settled farming country with very little uncultivated land. About one-half mile north of the river and running parallel with it for several miles is a stretch of woodland—portions of which are not pastured or otherwise disturbed. A few small streams enter the river on the north and on the south, but with the exception of a few ponds in an old limestone quarry at Grape there are no ponds or lakes in the region worked.

The reptile-amphibian fauna is limited now, both in species and individuals. Fourteen species were taken of which six were amphibians and eight reptiles. Several features have combined to cause a scarcity of these groups. Storms are very frequent along the lake shore and during the winter and spring months the strip of sand beach is frequently entirely submerged—destroying much of the animal life. Water birds are abundant and no doubt consume great numbers of

frogs and snakes in a season; many of the amphibians taken are badly mutilated. The frogs are hunted incessantly by fishermen for bait and food and all snakes are considered harmful and killed at sight. Practically the same conditions prevail up the river. The farmers are especially zealous in their attack on snakes. The country is thickly settled—has been cultivated for years and at the present time there is very little land that remains undisturbed for more than a season. Raccoons are common in the country west of Monroe and the small streams are bordered with paths made by them in their search for food which consists partly of amphibians. The fact that there are practically no permanent ponds, those formed in the spring existing only for a very short time, means that breeding conditions are unfavorable for forms which congregate in such places to breed.

LIST OF SPECIES.

Amphibia.

1. *Necturus maculosus* Rafinesque.—A single specimen was found dead on the beach after a hard storm. The fishermen report that this species is commonly taken in the spring in their nets in the lake and that it is also frequently caught in dip nets in the river at that season.
2. *Bufo americanus* LeConte.—Nine specimens were taken, eight of which were collected along the sand beach, where they seem to be common. Only one was seen up the river. The numerous insects on the beach furnish an abundance of food.
3. *Acris gryllus* LeConte.—The call of the cricket frog was heard in the swamp back of the sand beach at the Piers but none were observed there. Seven specimens were collected from the grass at the edge of the ponds in the quarry at Grape.
4. *Chorophilus nigritis* (LeConte).—A single specimen was taken under the bark of a fallen tree in a damp woods one-half mile north of the river and about four miles west of Monroe.
5. *Rana pipiens* Shreber.—The leopard frog is the most common amphibian of the region, although it is not present in large numbers. Thirty specimens were taken of which seventeen were collected in the marshes and along the shore of Lake Erie in the immediate vicinity of Monroe Piers. In this region they seemed to prefer the marshes and railroad embankment and were found in smaller numbers on the sand beach. West of Monroe they were collected in all of the habitats examined.
6. *Rana clamitans* Latreille.—A single specimen was taken at night

from a pond at Grape. Several others were heard at various times but they were not common.

Sauria.

7. *Eumeces quinquilineatus* (Linnaeus).—Seven individuals were taken in a woods one-half mile north of the river. The woods are apparently little disturbed and there are many fallen trees, old stumps and decaying logs. Three of the number are old individuals, and four are very recently hatched young.

Serpentes.

8. *Storeria dekayi* (Holbrook).—This species is apparently rather rare in the region, only two specimens being taken,—both in the woods north of the river.
9. *Elaphe vulpinus* (Baird & Girard) —A single specimen was collected by the roadside along the river bank on the eastern edge of the city of Monroe. We were told that formerly a "family" of these snakes lived for several years about an old stone pier up the river. The species is now only rarely seen in the county.
10. *Thamnophis surtalis* (Linnaeus).—The gartersnake was found in all the habitats studied. They were most common along the railroad embankment where there was considerable water on either side. On the marsh side the water was shallow and contained quantities of small fish and frogs which served as food. A few were taken along the beach, but they were not common there. Farther up the river this species was only rarely found, and the farmers reported it as uncommon.

Testudinata.

11. *Platypeltis spinifera* (LeSueur).—The soft shelled turtle was found in the river but was not common; only three specimens were taken.
12. *Chelydra serpentina* (Linnaeus).—The snapping turtle is common in the river, particularly above Monroe, where it is little disturbed.
13. *Chrysemys cinerea* (Bonnaterre).—Five specimens were taken from the river. It is a common species.
14 *Graptemys geographica* (LeSueur).—Although only five specimens were taken this seems to be the dominant turtle in the river.

RESULTS OF THE MERSHON EXPEDITION TO THE CHARITY ISLANDS, LAKE HURON: COLEOPTERA.

A. W. ANDREWS.

RESULTS OF THE MERSHON EXPEDITION TO THE CHARITY ISLANDS, LAKE HURON: COLEOPTERA.

A. W. ANDREWS.

The writer was a member of the Mershon Expedition of the University of Michigan for nine days in 1910. He was on the islands from June 19 to June 26 and on July 16 and 17. During this time the beetle fauna was studied carefully with the result that 623 species were obtained with habitat data[1]. The field work covered such a short period that much remains to be done, but conditions were so favorable and the results form such a considerable contribution to our knowledge of the fauna of these islands that it seems best to publish them.

The location and description of the Charities have been given by several men. Briefly, they consist of three small islands in the mouth of Saginaw Bay, and are distant about ten and eight miles from the south and north shores, respectively. Gull Island is the smallest of the group, and was not studied. Little Charity is second in size and has some forest cover. It was apparently poor in Coleoptera and received little attention. Charity Island, the largest in the group, contains about 650 acres, is densely wooded in the interior, supports a pond of about 2 acres, has extensive sand and rock beaches, and has been practically undisturbed by man It was found to be very rich in beetles and received practically all of the writer's attention.

HABITAT DISTRIBUTION OF THE COLEOPTERA.

The northeast beach of Charity Island proved to be the most important beetle habitat. A great number of specimens were found on the logs, rocks, stones, and sand, and on the bushes which are here but a few yards from the water's edge. At the time studied the conditions favored the concentration of beetles on this shore. The wind blew steadily for twelve out of fourteen days from the northeast, and the waves washed up specimens of various species and a considerable amount of food that attracted carnivorous species. Other species were obtained by beating the bushes and trees, on the top and under boards

[1] The writer is indebted to John D. Sherman, Jr., Brooklyn, N. Y., for the determination of many species of Carabidae and Dytiscidae; to A. B. Wolcott of the Field Museum of Natural History, Chicago for naming many species of Curculionidae and Elateridae, and to E. E. Swartz of the U. S. National Museum for a number of species of Curculionidae and Elateridae. He is also indebted to Captain Charles McDonald and his assistant, Joseph Singleton, of the lighthouse of Charity Island, for assistance in the field.

placed end to end on the damp sand Many species of water beetles were taken in the rock pools.

The southwest beach was, on the other hand, a very poor place for finding Coleoptera, even when the wind and waves were from the southwest. The strip of sand running parallel with the beach was far wider in extent on this shore, but was loose and dry and supported scattered shrubs and plants of various species; the sand being so loose and dry as to make it almost an impossibility for predaceous beetles to move on the surface. The trees, shrubs and flowering plants near the shore proved to be the best habitat for beetles. Many species were found here that did not appear on the northeast shore.

The other shores with a wide sandy beach proved to be very poor beetle habitats; little or nothing being found on them except one species of Cicindela. The interior of the island was also a poor beetle habitat. Some species of Cerambycids, however, were to be seen on the blossoms of New Jersey tea which grows along or near the path running across the island.

Contrary to expectation, the light from the lighthouse did not seem to attract the beetles It did, however, attract June flies, Ephemeridae, in vast numbers, for Captain McDonald informed the writer that on one morning he filled over six bushel baskets with the flies collected on the lighthouse platform. A number of species were found at night on the window screens and walls of the lighthouse, attracted by the lamp and white walls on the outside of the building, and many beetles were flying about the open space of land occupied by the lighthouse, some of which were taken with the net.

The number of species taken in each habitat is as follows:

355 only on or near the northeast shore.

116 only on or near the southwest shore.

32 found on or near both northeast and southwest shores.

4 in the interior of the island.

78 near the pig-pen, at or near the lighthouse, on flowering shrubs near the path to the lighthouse, at sugar lures on trees and in a lantern trap in the clearing.

Distribution by Families.

Family.	*Number of species.*	*Habitat.*
Carabidae	134	Northeast shore.
	12	Southwest shore.
	5	Northeast and southwest shores.
Dytiscidae and Hydrophilidae	39	Northwest shore
	12	In pond near southwest shore.
	7	Northeast and southwest shores.
Silphidae	3	Northeast shore.
	4	Southwest shore.
	1	Little Charity Island.
Staphylinidae	11	Northeast shore.
	1	Southwest shore.
	1	Interior of island.
Coccinellidae	13	Northeast shore.
	3	Southwest shore
Erotylidae	1	Northeast shore.
	4	Southwest shore.
Histeridae	3	Northeast shore.
	6	Southwest shore.
Elateridae	16	Northeast shore.
	17	Southwest shore.
	5	Northeast and southwest shores.
Buprestidae	10	Northeast shore.
	4	Southwest shore.
Lampyridae	3	Northeast shore.
	6	Southwest shore.
	1	Northeast and southwest shores.
Cleridae	2	Northeast shore.
	2	Southwest shore
	1	Northeast and southwest shores.
Lucanidae	3	Northeast shore.
	1	Little Charity Island.
Scarabaeidae	32	Northeast shore.
	5	Southwest shore.
	1	Northeast shore and center of island.
	2	Northeast and southwest shores.
	6	Near the pig-pen.
Cerambycidae	21	Northeast shore.
	13	Southwest shore.
	15	Near lighthouse.

Distribution by families.—Continued.

Family.	*Number of species.*	*Habitat.*
Chrysomelidae	10	Northeast shore.
	25	Southwest shore.
	2	Northeast and southwest shores.
Tenebrionidae	5	Northeast shore.
	5	Southwest shore
	4	Northeast and southwest shores.
Curculionidae	34	Northeast shore.
	6	Southwest shore.
	3	Northeast and southwest shores.
Calandridae	15	Northeast shore.

This is not a complete list of all the families found. A few of those represented by a small number of species are omitted.

Fauna of the Beaches. The writer believes that the greater part of the beetles seen on the northeast shore belonged to the island, that is bred there, and that the beetles undoubtedly washed up on this shore were either blown off the island or when flying off the shore dropped in the water when tired out and were washed ashore. As will be seen from the following data the wind was northeast twelve days out of the fourteen and the waves came from the direction of open water in Lake Huron: June 18-21 northeast, fair; June 22 southwest, fair; June 23-25 northeast, fair; June 26 southwest, cloudy; July 12-13 northeast; July 14 southwest, fair; July 15 northeast, variable, rain; July 16-17 northeast, blowing hard. Consequently the beetles would be in the water many days if they came from the mainland, and in order to strike the mile length of northeast shore on Charity Island, incredible numbers must have been scattered over the twenty mile width of Saginaw Bay. Also the low sandy shore on the mainland at Caseville ought to have received a large number if they came from the northeast, but the writer found none to speak of there.

The ability of our beetles to live in the water varies from two hours to seventy-two hours, if we except a few species of Curculionidae. By making a series of experiments the writer found the period of life in still water to be about as follows: Cicindela four hours. Twenty species of Carabidae four to twenty hours. In about twenty hours they became water-logged, most of them sinking to the bottom. *Harpalus caliginosus* lived forty-eight hours but was dead and water soaked in seventy-two hours. Elateridae, a number of species, did not live three hours. Buprestidae, some species did not live ten hours, most of them sinking to the bottom, but *Acemaeodera pulchella* was alive and

active at the end of seventy-two hours. Scarabacidae, a number of different species, died in forty to forty-eight hours. Chrysomelidae lived in the water twelve to forty-eight hours. Tenebrionidae, five or six species, lived only four to ten hours. Coccinellidae, all the various species experimented with lived forty-eight hours and were active up to that time, but were all dead in seventy-two hours and did not sink to the bottom. Curculionidae showed a rather wide range in their ability to resist the action of water, living in some cases only ten hours, others ranging from ten to seventy-two hours. *Cryptorhynchus lapathi* Linn.' seemed to be very hardy, as it was in good active condition after being in water for a week.

From these experiments the writer is convinced that the beetles on the northeast shore did not come from the mainland but from the island itself, and hence we do not have in the drift an explanation of the origin of the beetle fauna of the islands. A few species may have reached the island in this way, but of the great numbers that each year fall into the lake waters along the mainland shores very few would reach the island, as the most of them would be drowned long before they had traversed the distance. Very few, at least in recent years, would be carried by drift wood, as little or none is cast up on the shores. The bay is very free of anything of that description, although in the time of extensive lumbering in the Saginaw Bay region great quantities of lumber did come ashore and probably brought some of the species that are now breeding on the island. The dung beetles found on the island must have reached the island since the lighthouse was built, as before that time they could not live there. None of the large dung beetles were found on the shore of the islands, although very common on the mainland.

It is probable that most of the species have reached the islands by flight, and that the growth of the fauna has been slow and accompanied by an elimination of unfit species. Families that require particular conditions not found on the island are apparently not represented and the species that do not make long flights, such as Cicindelidae, are very poorly represented although the conditions are apparently favorable.

The isolation of the islands is apparently not great for beetles. Little or no variation from the mainland type in color or form can be seen in specimens found. This would be expected from the short distance from the mainland.

LIST OF SPECIES.

Cicindelidae.

1. *Cicindela sexguttata* Fab. One specimen found on the sandy path, near the southwest shore, June 16.

2. *Cicindela repanda* Dej. Four specimens taken on the dry sand of the east shore. It was breeding in this locality and a number were seen on June 26.
3. *Cicindela purpurea* Oliv. One specimen found running on the rocks of the northeast shore, June 26.

Carabidae.

4. *Omophron nitidum* Lec. Nine specimens found running on the beach and under the boards and debris on the northeast beach, June 24. Fairly common.
5. *Omophron dentatum* Lec. Nine specimens found running on the beach and under the boards and debris on the northeast beach, June 24. Fairly common.
6. *Omophron americanum* Dej. Two specimens found under boards, on the northeast shore, June 19.
7. *Carabus meander* Fisch. Six specimens found running on the sand and the rocks, on the northeast beach, July 17. It did not appear in June.
8. *Carabus serratus* Say. One specimen found on the northeast shore near the lighthouse, June 20.
9. *Calosoma scrutator* Fab. Two specimens running on the wet sand and the rocks, on the northeast shore, June 20-22.
10. *Calosoma willcoxi* Lec. One specimen running on the wet sand, on the northeast beach, near the lighthouse, June 22.
11. *Calosoma frigidum* Kirby. This species was seen in great numbers running on the wet sand and on the rocks, and under the boards and debris, on the northeast shore, June 19-20. One specimen was taken at a sugar lure on a tree near the lighthouse, the night of June 26.
12. *Calosoma calidum* Fab. This species was observed running on the sand and the rocks and under the boards and debris, on the northeast shore, June 19, 22 and July 17. Not common.
13. *Elaphrus clairvillei* Kirby. Six specimens found running under debris, very active, on the northeast beach, July 17.
14. *Elaphrus riparius* Linn. Eight specimens found hunting food on beach and under the boards and debris, on the northeast shore, July 19, 22. Fairly common.
15. *Elaphrus fuliginosus* Say. Two specimens were taken; they were observed on the beach and under debris, on the northeast shore, June 19-22.
16. *Blethisa quadricollis* Hald. One specimen found under the debris, on the northeast shore, July 17, very active.

17. *Loricera caerulescens* Linn. One specimen found under the debris, on the northeast shore near the lighthouse, July 17.
18. *Scarites subterraneus* Fab. Two specimens found in cells formed in the damp sand under a board, on the northeast shore, June 25.
19. *Clivina impressifrons* Lec. Found in numbers running on the sand of the northeast shore, June 20-22. Very common.
20. *Bembidium littorale* Oliv. One specimen found under the debris, on the southwest beach near the lighthouse, July 17.
21. *Bembidium americanum* Dej. One specimen found under the debris near the water on the northeast shore, July 17.
22. *Bembidium nigrum* Say. One specimen found under boards, on the northeast beach, June 20.
23. *Bembidium scopulinum* Kirby. Four specimens taken. It was observed running on the wet mud and rocks of the northeast shore, July 17. Fairly common.
24. *Bembidium versicolor* Lec. One specimen, found under debris, on the northeast beach, June 22.
25. *Bembidium assimile* Gyll. One specimen found under log, on the northeast beach, June 20.
26. *Patrobus longicornis* Say. Six specimens found under the washed up rushes on the southwest shore, July 17. Two found under the debris on the northeast shore, July 17.
27. *Pterostichus coracinus* Newm. Four specimens running on beach and under boards and debris, on the northeast beach, June 19.
28. *Pterostichus relictus* Newm. Two specimens found under debris, on the northeast beach, June 23.
29. *Pterostichus permundus* Say. One specimen found under the debris on the northeast beach, July 17.
30. *Pterostichus sayi* Bruelle. Five specimens found under boards, on the northeast beach, June 19. One found under a board near the water on the northeast beach, July 17.
31. *Pterostichus lucublandus* Say. Two specimens found under a board, on the northeast beach, June 20.
32. *Pterostichus caudicalis* Say. Six specimens found under boards and debris, on the northeast beach, June 19 and July 17.
33. *Pterostichus luctuosus* Dej. Two specimens found under boards, on the northeast beach, June 20.
34. *Pterostichus corvinus* Dej. Four specimens found under debris, on the northeast beach, June 19.
35. *Pterostichus scrutator* Lec. Two specimens found under a board, on the northeast beach, June 20.
36. *Pterostichus mutus* Say. Two specimens found under a board, on the northeast beach, June 22.

37. *Pterostichus pennsylvanicus* Lec. One specimen found under a board, on the northeast beach, June 26.
38. *Pterostichus erythropus* Dej. Two specimens found under a log, on southwest beach, June 19. One found under a board, on the northeast beach, June 22.
39. *Amara avida* Say. Two specimens found under a board, on the northeast beach, July 17.
40. *Amara exarata* Dej. Two specimens found under a board, on the northeast beach, June 23. One specimen found under a board, on the northeast beach, July 17.
41. *Amara latior* Kirby. Two specimens found under boards, on the northeast beach, July 17.
42. *Amara angustata* Say. One specimen found running on a log, on the northeast beach, June 24. One found under a board, on the northeast beach, July 17.
43. *Amara impuncticollis* Say. Two specimens found under debris, on the northeast beach, June 20.
44. *Amara crassispina* Lec. One specimen found under debris, on the northeast beach, June 22.
45. *Amara cupreolata* Putz. Three specimens found under a board, on the northeast beach, July 17.
46. *Amara fallax* Lec. One specimen found hunting on the sand, on the northeast beach, June 21.
47. *Amara protensa* Putz. Two specimens found hunting on damp sand, on the northeast beach, June 21.
48. *Amara polita* Lec. One specimen found under debris, on the northeast beach, July 17.
49. *Amara erratica* Sturm. Four specimens found running on the sand, on the northeast beach, June 20. Two found under flat stones, on the northeast beach, June 20.
50. *Amara interstitialis* Dej. One specimen found under a flat stone, on the northeast beach, June 20.
51. *Amara obesa* Say. Two specimens found under logs, on the northeast beach, June 20. Two found under boards, on the northeast beach, June 23. Six found under boards and debris, on the northeast shore, July 17.
52. *Amara remotestriata* Dej. One specimen found under a board, on the northeast beach, June 22. Three found under boards, on the northeast beach, July 17.
53. *Amara rubica* Hald. One specimen found under debris, on the northeast shore, July 17.
54. *Amara gibba* Lec. Three specimens found under debris, near the northeast shore, July 17.

55. *Amara subaenea* Lec. Five specimens found under boards, on the northeast beach, June 20. One found under debris, on the northeast beach, July 17. Very active.
56. *Amara musculus* Say. One specimen found on the sand near a log, on the northeast beach, June 21. Three found under the debris, on the northeast beach, June 22. Two found under boards, on the northeast beach, June 23.
57. *Amara* species near chalcea. Two specimens found under debris, near the northeast shore, July 17.
58. *Diplochila laticollis* Lec. Three specimens found under logs, on the southwest shore, June 20. Three found under a log, on the northeast beach, June 23.
59. *Diplochila laticollis* var. *major* Lec. Three specimens found under boards and one dead in the water, on the northeast shore, June 19. Four found under debris, on the northeast shore, July 17.
60. *Diplochila impressicollis* Dej. Four specimens found in cells made in the sand, under boards, on the northeast beach, June 22. Three found under a log, on the northeast beach, June 23. One found under a board, near northeast beach, July 17.
61. *Diplochila impressicollis* var. *alternans* Casey. This species was found under boards and debris, on the northeast shore, June 19 and July 17. Fairly common.
62. *Diplochila obtusa* Lec. Three specimens found under boards, on the northeast shore, June 22. One found under a board, on the northeast shore, July 17.
63. *Dicaelus purpuratus* Bon. One specimen found under a board, on the northeast beach, June 22.
64. *Badister pulchellus* Lec. One specimen found under debris, on the northeast beach, June 25.
65. *Calathus gregarius* Say. One specimen found under debris near the water on the northeast beach, July 17.
66. *Platynus hypolithus* Say. One specimen found under a flat stone, on the northeast beach, June 21.
67. *Platynus decens* Say. One specimen found under a board, on the northeast beach, June 22.
68. *Platynus sinuatus* Dej. Two specimens found under debris, on the northeast shore, July 17.
69. *Platynus opaculus* Lec. Two specimens found under a board, on the northeast beach, June 22.
70. *Platinus tenuicollis* Lec. Two specimens found under chips, on the northeast beach, June 23. Two found under debris, on the northeast beach, July 17.

71. *Platynus cincticollis* Say. Two specimens found under a log on the northeast beach, June 20.
72. *Platynus parmarginatus* Hamilton. Two specimens found under boards, on the northeast beach, June 20.
73. *Platynus reflexus* Lec. Six specimens found under boards, on the northeast beach, June 20.
74. *Platynus extensicollis* Say. Four specimens under debris, on the southwest shore, June 22. One found under debris, on the northeast shore, July 17.
75. *Platynus extensicollis* var. *viridis* Lec. Two specimens found under a board, on the northeast shore near the lighthouse, July 17.
76. *Platynus errans* Say. Two specimens found under debris, on the northeast shore, July 17.
77. *Platynus errans* var. *subcordatus* Lec. One specimen found under debris, on the northeast beach, July 17.
78. *Platynus moerens* Dej. Two specimens found under debris, on the northeast beach, June 20. One found under debris, on the northeast beach, July 17.
79. *Platynus tenuis* Lec. Three specimens found under washed up debris, on the northeast beach, June 20. One found under washed up debris, on the northeast shore, July 17.
80. *Platynus atratus* Lec. Two specimens found under boards on the debris on the northeast beach, June 19. One found under a log, on the southwest beach, July 17. One found under a board, on the northeast beach, July 17.
81. *Platynus malanarius* Dej. Two specimens found under a log, on the northeast beach, July 17.
82. *Platynus cupripennis* Say. Ten specimens found under boards on damp sand, on the northeast beach, June 17.
83. *Platynus excavatus* Dej. One specimen found under debris, on the northeast beach, June 17. One found under debris, on the northeast shore, July 17.
84. *Platynus ferreus* Hald. Two specimens found under loose bark of water-soaked log, on the northeast shore, July 17. Two found running on wet mud on the rocks of the northeast shore, July 17; very active.
85. *Platynus bogemanni* Gyll. One specimen found on the wet sand, on the northeast shore, June 19. Two found under debris, on the northeast beach, July 17; very active.
86. *Platynus quadripunctatus* DeG. Three specimens found under debris, on the northeast beach, July 17; very active.
87. *Platynus limbatus* Say. Two specimens found under damp debris, near the northeast beach, July 17.

88. *Platynus crenistriatus* Lec. Four specimens found under debris, near the northeast beach, July 17.
89. *Platynus rubripes* Zimm. Three specimens found on a stone, on the northeast shore, June 22.
90. *Platynus punctiformis* Say. One specimen found under a board, on the northeast beach, July 17.
91. *Platynus picipennis* Kirby. Two specimens found in a cell in sand under a board, also running on the sand of the northeast beach, June 21. One found under a board, on the northeast beach, July 17.
92. *Platynus lutulentus* Lec. Two specimens found running on the sand, on the northeast beach. One found under a board, on the northeast beach, June 23.
93. *Olisthropus parmatus* Say. One specimen found under a board, on the northeast beach, July 17.
94. *Casnonia pennsylvanica* Linn. Two specimens found crawling on the lighthouse walk, June 24.
95. *Galerita janus* Fab. Two specimens found under rotten log, near the southwest shore, June 24. One found under a board, on the northeast beach, July 17.
96. *Lebia grandis* Hentz. Two specimens found running on the northeast beach, June 22.
97. *Lebia atriventris* Say. One specimen found under a board, on the northeast beach, June 24.
98. *Lebia tricolor* Say. One specimen found on the sand, on the northeast beach, June 22.
99. *Lebia fuscata* Dej. One specimen taken by beating willows, near the southwest shore, June 22. One taken on a rotten log, near southwest shore, June 22.
100. *Lebia scapularis* Dej. One specimen found under a board, on the northeast beach, June 25.
101. *Lebia ornata* Say. Two specimens found under boards, on the southwest beach near the lighthouse, July 17.
102. *Callida punctata* Lec. One specimen found under the debris, on the northeast beach, June 20.
103. *Callida purpurea* Say. Two specimens under the boards, on the southwest beach near the lighthouse, July 17.
104. *Pinacodera limbata* Dej. Four specimens found under a log, on the northeast shore, June 19.
105. *Pinacodera platicollis* Say. Two specimens found under boards, near the northeast shore, July 17.
106. *Brachynus perplexus* Dej. One specimen found under debris at water's edge, on the southwest shore, July 17.

107. *Brachynus medius* Harr. Two specimens found under debris, on the northeast beach, July 25.
108. *Brachynus quadripennis* Dej. One specimen taken in a lantern trap in the woods, near the lighthouse, June 26.
109. *Brachynus cyanipennis* Say. Three specimens found under the debris, on the northeast beach, June 25.
110. *Brachynus alternans* Dej. One specimen found under a board, on the northeast beach, June 19.
111. *Brachynus cordicollis* Dej. One specimen found under debris, on the northeast beach, June 25.
112. *Brachynus ballistarius* Lec. One specimen found under a stone, on the northeast beach, June 20.
113. *Brachynus gracilis* Blatchley. Two specimens found under boards, near the northeast shore, July 17.
114. *Chlaenius erythropus* Germ. Six specimens found running, on the northeast beach, June 25.
115. *Chlaenius sericeus* Forst. Four specimens found under the boards and debris, on the northeast beach, June 19-22. Fairly common.
116. *Chlaenius diffinis* Chand. Eight specimens found running under loose debris at the edge of the water, on the northeast beach, June 17.
117. *Chlaenius solitarius* Say. Two specimens found under a board, on the northeast beach, June 20.
118. *Chlaenius impunctifrons* Say. Two specimens found under boards, on the south shore, June 23.
119. *Chlaenius tricolor* Dej. One specimen found under a board, on the northeast shore, June 20.
120. *Chlaenius nemoralis* Say. Two specimens taken under flat stones, on the northeast shore, June 20.
121. *Chlaenius pennsylvanicus* Say. Six specimens taken under debris, on the northeast shore, June 20.
122. *Chlaenius niger* Rand. Two dead specimens found under a board, on the northeast beach, June 21. One found under a board, on the northeast beach, July 17.
123. *Chlaenius tomentosus* Say. Four specimens found under boards, on the northeast beach, July 17.
124. *Brachylobus lithophilus* Say. Three specimens found under a board on the sand, on the northeast beach, June 20. Two found running under debris at the edge of the water, on the northeast beach, July 17.
125. *Lachnocrepis parallelus* Say. Six specimens found under boards, on the northeast beach, June 23.

126. *Oodes amaroides* Dej. One specimen found under debris, on the northeast beach, June 23.

127. *Oodes americanus* Dej. One specimen found under a board, on the northeast beach, July 17. One found under debris, on the northeast beach, July 17.

128. *Oodes fluvialis* Lec. Two specimens found under a board, on the northeast beach, July 17.

129. *Geopinus incrassatus* Dej. Six specimens found under boards and debris, on the northeast beach, June 19-22.

130. *Agonoderus pallipes* Fab. Eight specimens were found, some under boards, some hunting on damp sand, and others digging into the moist sand under logs and boards, on the northeast beach, July 21.

131. *Gynandropus hylacis* Say. One specimen found alive in rock pool, on the northeast shore, June 21.

132. *Harpalus autumnalis* Say. One specimen found under decaying plank, near the northeast shore, July 17.

133. *Harpalus erraticus* Say. One specimen found under a board, on the northeast beach, June 25. Four making cells in damp sand underneath boards, on the northeast shore, July 17. Very common.

134. *Harpalus caliginosus* Fab. Four specimens found under the boards and debris, on the northeast shore, June 16-25. Common.

135. *Harpalus pennsylvanicus* Dej. Four specimens found under a decaying plank, near the southwest shore, July 17.

136. *Harpalus pennsylvanicus* var. *erythropus* Dej. Two specimens found under a decaying plank, near the southwest shore, July 17.

137. *Harpalus herbivagus* Say. One specimen found under a board, on the northeast beach, June 29.

138. *Harpalus laticeps* Lec. Two specimens found under a log, on the southwest shore, July 17.

139. *Harpalus viduus* Lec. One specimen found under a log, on the southwest beach, June 22.

140. *Selenophorus opalinus* Lec. One specimen found running under debris, on the northeast beach, June 22. One found under a board, on the northeast beach, July 17.

141. *Stenolophus dissimilis* Dej. One specimen found on a flat stone, on the northeast beach, June 21.

142. *Stenolophus ochropezus* Say. One specimen found on a flat rock, on the northeast shore, June 26.

143. *Stenolophus fulginosus* Dej. One specimen found under a board, on the northeast beach, July 17.

144. *Selenophorus* sp. One specimen found under a board, on the northeast beach, June 22.

145. *Anisodactylus harrisii* Lec. One specimen found under a board, on the northeast shore, June 24.

146. *Anisodactylus rusticus* Dej. Three specimens found under some boards, and one under a stone, on the northeast beach, June 19-23. One under a board, on the northeast beach, July 17.

147. *Anisodactylus interpunctatus* Kirby. One specimen found under debris, on the northeast beach, June 23.

148. *Anisodactylus nigerrimus* Dej. Three specimens found under boards, on the northeast beach, June 19. Six running under boards and debris, on the northeast beach, July 17. One under a board, on the northeast beach, July 17.

149. *Anisodactylus discoideus* Dej. Six specimens found hunting on the sand near logs, on the northeast beach, June 21.

150. *Anisodactylus baltimorensis* Say. Two specimens found under a log, on the northeast shore, June 19. One found under a board at the water edge, southwest beach, June 20.

151. *Anisodactylus sericeus* Harr. One specimen found under a board, on the northeast beach, July 17.

152. *Anisodactylus verticalis* Lec. One specimen found under debris, on the sand of the northeast beach, June 21.

153. *Anisodactylus interstitialis* Say. Two specimens found under a log, on the northeast beach, June 20.

Dytiscidae.

154. *Laccophilus maculosus* Germ. Five specimens found in the rock pools, on the northeast shore, July 16.

155. *Coelambus inaequalis* Fab. Six specimens found in the mud of the pond, near the southwest shore, July 17.

156. *Coelambus impresso-punctatus* Sch. Two specimens found crawling on the wet rocks, on the northeast shore, June 21. Six taken by dredging pond, July 17.

157. *Coelambus turbidus* Lec. One specimen taken by dredging pond, July 17.

158. *Deronectes griseostriatus* DeG. One specimen found swimming in rock pool, on the northeast shore, June 23.

159. *Hydroporus laccophilinus* Lec. One specimen found in a rock pool, on the northeast side shore, July 17.

160. *Hydroporus undulatus* Say. Fifteen specimens taken by dredging pond, July 17.

161. *Hydroporus tristis* Payk. One specimen taken by dredging mud at edge of pond, July 17.

162. *Hydroporus dichrous* Melsh. Two specimens found in the mud of the pond, July 17.

163. *Hydroporus modestus* Aubé. Two specimens found swimming in rock pool, on the northeast shore, July 17.

164. *Ilybius ignarus* Lec. Two specimens found in a pool, on the northeast shore, June 21.

165. *Ilybius confusus* Aubé. Four specimens found swimming in a rock pool, on the northeast shore, July 17.

166. *Coptotomus interrogatus* Fab. Eight specimens found in rock pools, on the northeast shore, June 25. Seven taken by dredging pond, July 17.

167. *Matus bicarinatus* Say. Ten specimens found in the rock pools, on the northeast shore, June 23. One found by dredging pond, July 17. Six taken in rock pools, on the northeast shore, July 17.

168. *Agabetes acuductus* Harr. Two specimens taken in the rock pools, on the northeast shore, July 17.

169. *Ilybiosoma bifarius* Kirby. One specimen found swimming in rock pool, on the northeast shore, June 21.

170. *Agabus obtusatus* Say. One specimen found in a rock pool, on the northeast shore, July 17.

171. *Agabus subfuscatus* Sharp. Five specimens taken in the rock pools, on the northeast shore, June 23-24. Two taken by dredging pond, July 17.

172. *Rhantus binotatus* Harr. Two specimens were taken in the water of the bay, near some rocks, on the northeast shore, June 21.

173. *Rhantus bistriatus* Bergst. Three specimens found by dredging pond, July 17.

174. *Colymbetes sculptilis* Harr. Ten specimens taken in rock pools, on the northeast shore, June 21. Three taken in rock pools, on the northeast shore, July 19.

175. *Hydaticus piceus* Lec. One specimen found in the rock pools, on the northeast shore, June 23. One found in the rock pools, on the northeast shore, July 16.

176. *Hydaticus stagnalis* Fab. One specimen found swimming in rock pool, on the northeast shore, June 22.

177. *Dytiscus fasciventris* Say. Two specimens found in the rock pools, on the northeast shore, June 23. Three taken in the rock pools, on the northeast shore, July 16.

178. *Dytiscus verticalis* Say. One specimen taken in the rock pools, on the northeast shore, July 16.

179. *Dytiscus sublimbatus* Lec. Six specimens found crawling in wet sand near the water edge, on the northeast shore, July 16.

180. *Dytiscus marginalis* Linn. Two specimens found swimming in the water of the bay, on the northeast shore, July 16.
181. *Dytiscus hybridus* Aubé. One specimen found swimming in rock pool, on the northeast shore, June 25. Six specimens found crawling in wet sand at the edge of the water, on the northeast shore, July 16.
182. *Dytiscus harrisii* Kirby. Two specimens found swimming in rock pool, on the northeast shore, June 21.
183. *Acilius semisulcatus* Aubé. Two specimens taken in the rock pools, on the northeast shore, June 21-22. Five found by dredging pond, July 17.
184. *Acilius fraternus* Harr. Three specimens taken by dredging in the pond, July 17.
185. *Graphoderus liberus* Say. Ten specimens taken by dredging pond, July 17.
186. *Cybister fimbriolatus* Say. Two specimens found in the rock pools, on the northeast shore, June 23.

Gyrinidae.

187. *Gyrinus aeneolus* Lec. One specimen found in a rock pool, on the northeast shore, July 17.
188. *Gyrinus lugens* Lec. Nine specimens found under boards and debris at the edge of the water, on the northeast shore, July 17.
189. *Dineutes emarginatus* Say. Six specimens found swimming on the surface of the pond, July 17. Common.
190. *Dineutes hornii* Roberts. Two specimens found in the rock pools, on the northeast shore, June 23.
191. *Dineutes nigrior* Roberts. Two specimens found swimming in a rock pool, on the northeast shore, July 17.

Hydrophilidae.

192. *Helophorus lacustris* Lec. Three specimens found crawling under wet debris near the edge of the water, on the northeast shore, July 17.
193. *Helophorus lineatus* Say. Two specimens taken on the wet sand and two on a log, on the northeast shore, June 21-25.
194. *Helophorus tuberculatus* Gyll. One specimen taken under debris, on the northeast shore, July 17.
195. *Hydrochus excavatus* Lec. One specimen found crawling on wet rocks, on the northeast shore, June 21.
196. *Hydrophilus triangularis* Say. One specimen taken in a rock pool, on the northeast shore, July 17.

197. *Tropisternus nimbatus* Say. One specimen found by dredging pond, July 17. One found swimming in a rock pool, on the northeast shore, July 17.

198. *Tropisternus mixtus* Lec. Ten specimens taken by dredging among roots of the water plants in the pond, July 17.

199. *Tropisternus glaber* Hbst. One specimen found swimming in the rock pools, on the northeast shore, June 23. One in a rock pool, July 17.

200. *Tropisternus sublaevis* Lec. One specimen taken in a rock pool, on the northeast shore, June 21.

201. *Hydrocharis obtusatus* Say. Two specimens found in the water of the bay, near the northeast shore, June 21. Three crawling up from the water, July 16. One swimming in a rock pool, July 17.

202. *Berosus striatus* Say. One specimen found under a board on the wet sand, on the northeast shore, June 24.

203. *Berosus infuscatus* Lec. One specimen found on the wet rocks, on the northeast shore, June 21. Two found in rock pools, June 23. Four found in rock pools, July 17.

204. *Cymbiodyta blanchardi* Horn. Two specimens taken by dredging the pond, July 17.

205. *Philhydrus bifidus* Lec. Five specimens found in the rock pools, on the northeast shore, June 23. Fifteen found in the rock pools, on the northeast shore, July 17.

206. *Helochares maculicollis* Muls. Three specimens taken by dredging at edge of pond, July 17.

207. *Philhydrus ochraceus* Mels. One specimen taken on wet rocks, on the northeast shore, June 26. One found swimming in rock pools, on the northeast shore, July 17. One found by dredging the pond, July 17

208. *Philhydrus cinctus* Say. One specimen found on a stone, on the northeast beach, June 17.

209. *Philhydrus hamiltoni* Horn. Four specimens taken by dredging the mud of the small pond, near southwest shore, July 17.

210. *Hydrobius tessellatus* Ziegl. Three specimens taken on the sand, on the northeast shore, June 20.

211. *Hydrobius fuscipes* Linn. Three specimens found swimming in the rock pools, on the northeast beach, June 21. Seven found in the rock pools, on the northeast beach, July 17.

212. *Creniphilus subcupreus* Say. One specimen taken in rock pool, on the northeast shore, June 26. One in pool on rocks, on northeast shore, July 17.

213. *Cercyon nigriceps* Marsh. One specimen found by dredging on edge of pond, July 17.

Silphidae.

214. *Necrophorus sayi* Lap. Two specimens found under a dead fish, on the northeast shore, June 23.
215. *Necrophorus americanus* Oliv. One specimen found beside a dead fish, on the south shore of Little Charity, June 23.
216. *Necrophorus pustulatus* Hersch. One specimen found under a dead fish, on the northeast beach, June 22.
217. *Necrophorus vespilloides* Hbst. One specimen found under a dead fish, on the southwest shore, July 17.
218. *Necrophorus tormentosus* Web. One specimen found under a dead fish, on the southwest shore, July 17.
219. *Silpha surinamensis* Fab. Two specimens found under a dead fish, on the southwest shore, July 17.
220. *Silpha noveboracensis* Forst. One specimen found under a dead fish, on the northeast shore, July 17.
221. *Silpha americana* Linn. One specimen taken in decaying fungi on a log, on the southwest shore, June 26.

Staphylinidae.

222. *Creophilus villosus* Grav. Two specimens taken in a decayed pickerel, on the northeast shore, June 20. One found under a dead fish on the sand, on the northeast shore, July 17.
223. *Staphylinus badipes* Lec. One specimen found under a board, on the northeast shore, June 26.
224. *Staphylinus tomentosus* Grav. Two specimens taken under damp debris, near the northeast shore, June 26. Three taken under damp debris, near the northeast shore, July 17
225. *Philonthus sericinus* Horn. Two specimens found crawling on a log, on the northeast beach, June 25.
226. *Philonthus umbrinus* Grav. One specimen found crawling on the beach, near the lighthouse, June 26.
227. *Philonthus cyanipennis* Fab. Two specimens taken in fungi growing on a log, near the southwest shore, June 26.
228. *Xantholinus emmesus* Grav. Two specimens found running under bark, on the northeast shore, June 24.
229. *Cryptobium bicolor* Grav. Two specimens taken under debris on the rocks, on the northeast shore, June 22.
230. *Cryptobium pusillum* Lec. One specimen found under a board, on the northeast shore, June 25.

231. *Cryptobium sellatum* Lec. One specimen found under debris, on the northeast shore, June 22.

232. *Stilicus tristis* Melsh. Three specimens found running on damp sand near logs, on the northeast beach, June 22. Six found running under debris, on the northeast beach, July 17.

233. *Boletobius pygmaeus* Fab. Five specimens taken in fungi, near the center of the island, June 26.

234. *Acidota crenata* Fab. Four specimens found under cut and dried milk-weed, on the northeast shore near the lighthouse, July 17.

Coccinellidae.

235. *Megilla maculata* DeG. Two specimens taken on leaves of willow, near the northeast shore, June 26. Four found crawling on rocks, logs, and milkweed near the northeast shore, July 17.

236. *Hippodamia 5-signata* Kirby. Five specimens found on large stones, on northeast shore, June 20. One found crawling on a log, on the northeast shore, June 24. Two found crawling on a log, on the northeast shore, July 17.

237. *Hippodamia convergens* Guer. One specimen found on willow, on the northeast shore, June 20.

238. *Hippodamia 13-punctata* Linn. Two specimens taken on leaves of birch, on the northeast shore, June 20. Thousands crawling on rocks and logs in about 100 feet in length of beach, hundreds mating, July 17.

239. *Hippodamia parenthesis* Say. Seven specimens taken on leaves of basswood, on the northeast shore, June 20. One taken on leaves of willow, on the northeast shore, June 21. Thousands were observed in a small area on logs and rocks, on the northeast shore, July 17.

240. *Coccinella trifasciata* Linn. One specimen taken on willow, on the northeast shore, June 21. One found crawling on a log, on the northeast beach, July 17.

241. *Coccinella 9-notata* Hbst. Three specimens taken on logs, on the northeast shore, June 20.

242. *Coccinella tricuspis* Kirby. One specimen taken by beating willow, near the southwest shore, June 24.

243. *Coccinella sanguina* Linn. One specimen taken on a stone, on the northeast beach, June 20. Six taken on logs, rocks, and milkweeds, on the northeast shore, July 17. Common.

244. *Adalia bipunctata* Linn. Two specimens taken on milkweed, near the lighthouse, July 17.

245. *Harmonia picta* Rand. One male and one female specimen taken

on the flowers of Jersey tea, along the path near the lighthouse, July 17.

246. *Anatis 15-punctatus* Oliv. Five specimens (dark form) found crawling on logs, on the northeast beach, June 20. Six specimens (light form) taken from larger rocks, on the northeast beach, July 17.

247. *Anatis 15-punctatus* var. *mali* Oliv. Five specimens found crawling on logs and boards, on the northeast beach, June 25. Nine found crawling on the rocks, on the northeast beach, July 17.

248. *Psyllobora 20-maculata* Say. Five specimens taken on blossoms of red-stemmed dogwood, near the northeast shore, June 24.

249. *Chilocorus bivulnerus* Muls. Six specimens taken on leaves of willow, on the northeast shore, June 20.

250. *Brachyacantha ursina* Fab. Ten specimens taken by beating the foliage of willows, on the southwest shore, June 23.

251. *Brachyacantha 10-pustulata* Melsh. One specimen taken on the flowers of dogwood, on the northeast shore, June 24.

Erotylidae.

252. *Dacne 4-maculata* Say. Ten specimens found in fungi on trunk of tree, near southwest shore, June 21.

253. *Megalodacne fasciata* Fab. Two specimens found in fungi in the woods, near the southwest shore, July 17.

254. *Megalodacne heros* Say. One specimen taken in fungi on a log, near the southwest shore, June 24.

255. *Ischyrus quadripunctatus* Oliv. One specimen found in fungi in the woods, near the southwest shore, June 21.

256. *Tritoma thoracica* Say. Five specimens taken in fungi on logs, on the northeast beach, June 23.

257. *Tritoma flavicollis* Lec. Two specimens found in dry fungi on a log, near the southwest shore, June 22.

Cucujidae.

258. *Brontes dubius* Fab. Three specimens taken under the bark of an oak log, on the northeast shore, June 26.

Cryptophagidae.

259. *Tisactia subglabra* Casey. One specimen taken on a willow, near the northeast shore, June 21.

Mycetophagidae.

260. *Mycetophagus flexuosus* Say. Two specimens taken in fungi, near the southwest shore, June 21. Seven taken in fungi on an ash tree, near the southwest shore, June 26.
261. *Mycetophagus bipustulatus* Melsh. Five specimens found in fungi on a dead tree, near the southwest shore, June 20.
262. *Mycetophagus pluripunctatus* Lec. Four specimens taken in fungi, near the southwest shore, June 26. One found under a log, on northeast shore, June 27.
263. *Litargus tetraspilotus* Lec. One specimen found under debris, on the southwest shore, June 22.

Dermestidae.

264. *Dermestes caninus* Germ. One specimen found under a dead fish, on the northeast beach, June 26.
265. *Dermestes lardarius* Linn. One specimen taken on the floor of the lighthouse, June 22. One taken in the lighthouse, July 17.
266. *Anthrenus castaneae* Melsh. Three specimens taken on blossoms of red stemmed dogwood near northeast shore, June 26.

Histeridae.

267. *Hololepta fossularis* Say. One specimen taken on a willow, near the southwest shore, June 22.
268. *Hister foedatus* Lec. Three specimens taken in decayed fungi on a paper birch, near the southwest shore, June 23.
269. *Hister depurator* Say. One specimen found under a log, on the southwest beach, June 21.
270. *Hister sedecimstriatus* Say. One specimen taken in decayed fungi, near the southwest shore, July 17.
271. *Hister nubilus* Lec. Two specimens found under a board on the sand, on the northeast beach, June 21.
272. *Saprinus lugens* Erichs. One specimen found under debris, on the northeast shore, July 17.
273. *Saprinus fraternus* Say. One specimen taken in fungi, near the southwest shore, July 17.
274. *Saprinus fitchii* Mars. One specimen found in dried fungi, near the southwest shore, June 22. One found in fungi, on the southwest shore, July 17.
275. *Saprinus patruelis* Lec. One specimen found under a board, on the northeast beach, July 17.

Nitidulidae.

276. *Epuraea corticina* Erichs. One specimen found under debris, near the northeast beach, July 17.

277. *Phenolia grossa* Fab. One specimen taken in fungi, near the southwest shore, June 21.

278. *Ips quadriguttatus* Fab. A dark variety found feeding at sap of a sugar maple, near the northeast shore, June 23. Two specimens taken feeding at sap of a maple, near the lighthouse, July 17.

279. *Ips sanguinolentus* Oliv. Three specimens taken in decaying fungi on logs, on the southwest shore, June 21.

Lathridiidae.

280. *Enicmus minutus* Linn. Two specimens found under cut and dried milkweed, near the southwest shore, June 19.

281. *Enicmus consimilis* Mann. Two specimens taken under debris, on the northeast beach, June 24.

Byrrhidae.

282. *Cytilus sericeus* Forst. One found under a log, on the northeast shore, June 25.

283. *Cytilus trivittatus* Melsh. Two specimens taken on a log, on the northeast beach, June 20.

284. *Byrrhus americanus* Lec. Four specimens taken on the sand, on the northeast beach, June 25.

285. *Byrrhus kirbyi* Lec. One specimen found under a board, on the northeast beach, June 22.

Heteroceridae.

286. *Heterocerus brunneus* Melsh. One specimen found under a board, on the northeast beach, June 25.

Dascyllidae.

287. *Eucinetus testaceus* Lec. One specimen found in decayed fungi, near southwest shore, June 26.

288. *Prionocyphon discoideus* Say. One specimen taken in a pool on the rocks, on the northeast shore, July 17.

289. *Cyphon variabilis* Thunb. One specimen taken in fungi, near southwest shore, June 23.

Elateridae.

290. *Fornax orchesides* Newm. Two specimens found under the bark of a dead ash, near the southwest shore, July 17.

291. *Adelocera discoidea* Web. One specimen found by beating the willows, near the northeast shore, June 26.

292. *Adelocera brevicornis* Lec. Two specimens found by beating the willows, near the northeast shore, June 26.

293. *Alaus oculatus* Linn. Two specimens taken on a log, near the northeast shore at lighthouse, June 23.

294. *Alaus myops* Fab. One specimen caught flying near the lighthouse, June 23.

295. *Cardiophorus convexus* Say. One specimen found on wild grape, near the lighthouse, June 20. Another, taken at sugar lure on tree, near the lighthouse, the night of June 20.

296. *Cardiophorus cardisce* Say. One specimen taken, on the northeast beach, June 20. One found by beating a willow, near the southwest shore, June 23.

297. *Cardiophorus convexulus* Lec. One specimen taken on the flowers of red-stemmed dogwood, near the northeast shore, June 23. One found under the bark of a dead oak, near the southwest shore, July 17.

298. *Cardiophorus gagates* Erichs. One specimen taken on leaves of a red oak, near the northeast shore, June 23.

299. *Cardiophorus laevicollis* Er. Two specimens taken by beating red-stemmed dogwood, near the northeast beach, July 17.

300. *Cardiophorus robustus* Lec. One specimen taken by beating branches of Norway pine, near southwest shore, June 23. One on pine, near southwest shore, July 17.

301. *Cryptohypnus abbreviatus* Say. One specimen found floating in rock pool, on northeast shore, June 26.

302. *Monocepidius suturalis* Lec. One specimen taken on the leaves of a willow, on the northeast shore, June 20.

303. *Dicrepidius corvinus* (Cand.). Three specimens found under the bark of a dead oak, near the southwest shore, July 17.

304. *Elater hepaticus* Melsh. Two specimens taken on an oak, near the southwest shore, July 17.

305. *Elater pedalis* Germ. Five specimens taken under the bark of a dead oak branch, near the southwest shore, July 17. Fairly common.

306. *Elater subtilis* Lec. One specimen found on flowers of red-stemmed dogwood, near the northeast shore, June 21. One taken by beating the branches of a white pine, near the southwest shore, June 23.

307. *Elater luctuosus* Lec. One specimen taken on flowers of Jersey tea, near the northeast shore, July 17.

308. *Elater rubricus* Say One specimen taken by beating the leaves of basswood, on the northeast shore, July 17. Seven taken on the oaks, near the southwest shore, July 17.

309. *Elater areolatus* Say Four specimens taken on the leaves and flowers of red-stemmed dogwood, on the northeast shore, June 20. Three found by beating branches of birch, near northeast shore, July 17.

310. *Drasterius elegans* Fab. Eight specimens taken on the logs, on the northeast beach, June 20.

311. *Ludius attenuatus* Say. Two specimens found by beating branches of willows, near southwest shore, June 26. One taken by beating the branches of basswood, near the northeast shore, July 17.

312. *Agriotes stabilis* Lec. Five specimens taken on the branches of white pine, near the northeast shore, June 20. Seven found on the leaves and branches of the white pine, near the southwest shore, June 21-23.

313. *Agriotes fucosus* Lec. Two specimens taken by beating the leaves of willows, near the southwest shore, June 26.

314. *Agriotes pubescens* Melsh. Two specimens taken on leaves on a Norway pine, near the southwest shore, June 24.

315. *Agriotes limosus* Lec. Five specimens taken by beating the branches of a Norway pine, near the southwest shore, June 23.

316. *Agriotes avulsus* Lec. One specimen taken on a dead branch of a yellow oak, near the southwest shore, June 22.

317. *Dolopius lateralis* Esch. Four specimens found on flowers of red-stemmed dogwood, on the northeast shore, June 20.

318. *Melanotus corticinus* Say. Two specimens found by beating foliage of yellow oak, near northeast shore, June 20.

319. *Melanotus decumanus* Erichs. Two specimens taken by beating the branches of a birch, near the northeast shore, July 17.

320. *Melanotus canadensis* Cand. One specimen taken on a branch of an oak, near the southwest shore, July 17.

321. *Melanotus glandicolor* Melsh. One specimen taken by beating willows, near the southwest shore, July 17.

322. *Melanotus communis* Gyll. Two specimens found under bark of dead oak, near center of island, June 26.

323. *Melanotus castanips* Payk. One specimen taken on a branch of a yellow oak, near the northeast shore, June 20. One found by beating a red oak, near the southwest shore, June 25.

324. *Melanotus fissilis* Say. One specimen found on an oak leaf, near the southwest shore, June 20. Two taken under the bark of a dead oak, near the southwest shore, July 17.

325. *Melanotus parumpunctatus* Melsh. Two specimens taken by beating the branches of a yellow oak, near the southwest shore, June 23.
326. *Limonius aurifer* Lec. Two specimens taken on the leaves of a willow, near southwest shore, June 21.
327. *Pityobius anguinus* Lec. One specimen found crawling on a log, on the northeast beach, June 23. One male specimen found crawling on a log and one female specimen found, on the northeast beach, June 25. Several specimens picked up on the northeast beach in August by Captain McDonald.
328. *Sericosomus viridanus* Say. Two specimens taken on a birch, near the lighthouse shore, July 17.
329. *Sericosomus silaceus* Say. One specimen taken by beating the birch, near the northeast shore, June 23. Four taken on the flowers of dogwood, on the northeast shore, July 17.
330. *Athous stabilis* Lec. Two specimens taken by beating the branches of a red oak, near southwest shore, June 23. Two taken by beating a June-berry bush, near the southwest shore, July 17.
331. *Corymbites sulcicollis* Say. One specimen taken at a sugar lure, on a tree in woods near the lighthouse, night of June 26.
332. *Corymbites propola* Lec. One specimen taken on mullein, near the southwest shore, July 17.
333. *Corymbites hieroglyphicus* Say. Two specimens taken by beating the branches of a white pine, near the southwest shore, June 23.
334. *Corymbites tessclatus* Linn. One specimen found at sap running from sugar maple, near the northeast shore, June 23.
335. *Corymbites pyrrhos* Hbst. One specimen taken by beating the branches of a white pine, near the southwest shore, June 23.
336. *Asaphes decoloratus* Say. One specimen taken in a lantern trap, in the woods near the lighthouse, June 26.
337. *Asaphes memnonius* Hbst. One specimen found under a board, on the northeast shore, July 17.

Buprestidae.

338. *Dicerca divaricata* Say. One specimen found on a dead branch of a yellow oak, near the lighthouse, June 20.
339. *Poecilonota cyanipes* Say. One specimen found crawling on an oak log, near the northeast beach, July 17.
340. *Buprestis nuttalli* Kirby. Two specimens taken on a log, on the northeast beach, July 17.
341. *Buprestis maculiventris* Say. One specimen taken on a log, on the northeast beach, June 23.

342. *Buprestis fasciata* Fab. Two specimens found crawling on a board, on the northeast beach, July 17.
343. *Buprestis fasciata* var. *langii* Mann. Two specimens taken under a log, on the northeast beach, June 25.
344. *Melanophila longipes* Say. Four specimens taken on a log, on the northeast beach, June 20. Seven found crawling on logs, boards and rocks, on the northeast shore, July 17.
345. *Melanophila fulvoguttata* Harr. Three specimens taken on a pine log, on the northeast shore, June 20. Five found crawling on logs and rocks, on the northeast shore, July 17.
346. *Agrilus otiosus* Say. Two specimens taken on a willow, near the northeast beach, June 23.
347. *Agrilus acutipennis* Mann. One specimen found on the leaves of an oak, near the northeast shore, June 23.
348. *Agrilus anxius* Gory. Two specimens taken by beating the willows, near the southwest shore, July 17.
349. *Agrilus politus* Say. Four specimens taken by beating the willows, near the southwest shore, June 23.
350. *Brachys ovata* Web. Two specimens taken by beating the branches of Norway pine, near the southwest shore, June 23.
351. *Brachys aeruginosa* Gory. Two specimens found crawling on logs under debris, on the northeast beach, June 22.

Lampyridae.

352. *Eros trilineatus* Melsh. One specimen taken by beating the willows, near the southwest shore, July 17.
353. *Lucidota atra* Fab. One specimen taken by beating the birch, near the northeast shore, July 17.
354. *Ellychnia corrusca* Linn. One specimen found by beating the willows, near the southwest shore, July 17.
355. *Photinus pyralis* Linn. Three specimens taken by beating the willows, near the southwest shore, July 17.
356. *Photinus marginellus* Lec. Two specimens taken by beating the willows, near the southwest shore, June 25.
357. *Photuris pennsylvanica* DeG. One specimen taken by beating the willows, near the southwest shore, July 17.
358. *Telephorus dentiger* Lec. Three specimens found on a small birch, near the southwest shore, June 22.
359. *Telephorus carolinus* Fab. Three specimens found by beating small birch, near the northeast shore, June 22.
360. *Telephorus scitulus* Say. One specimen taken on the blossoms of red-stemmed dogwood, near the northeast shore, June 23.

361. *Telephorus tuberculatus* Lec. Two specimens taken in the blossoms of wild rose, near the pond, July 17.

Malachiidae.

362. *Collops quadrimaculatus* Fab. One specimen found under cut and dried milkweed, on the northeast shore, near the lighthouse, July 17.
363. *Collops vittatus* Say. Five specimens taken on a mullein, near the southwest shore. Two found under dried milkweed, near lighthouse, July 17.
364. *Anthocomus flavilabris* Say. One specimen taken on the flowers of dogwood, near the southwest shore, June 22.

Cleridae.

365. *Trichodes nuttalli* Kirby. Eight specimens taken on the blossoms of wild rose, near the southwest shore, June 22. Three taken on milkweed blossoms, in clearing at lighthouse, June 23.
366. *Clerus analis* Lec. One specimen taken on a log, near the northeast shore, July 17.
367. *Clerus quadriguttatus* Oliv. One specimen captured flying, near the lighthouse, June 22.
368. *Thanerocleras sanguineus* Say. Two specimens taken on the trunk of a dead oak, near the southwest shore, July 17.
369. *Hydnocera pedalis* Lec. Five specimens taken on flowers of dogwood, on the southwest shore, June 21. One taken on flowers of dogwood, on the northeast shore, June 23.
370. *Ellipotoma laticornis* Say. One specimen taken in the flowers of a wild rose, on the northeast shore, June 21. One taken on the blossoms of red-stemmed dogwood, near the northeast shore, June 26.

Ptinidae.

371. *Xyletinus peltatus* Harr. Two specimens taken by beating the willows, near the northeast shore, June 23.
372. *Ptilinus ruficornis* Say. Four specimens found breeding and boring in the bark of a dead oak, near the northeast shore, June 26.

Bostrichidae.

373. *Bostrichus bicornis* Web. Two specimens found under a board, on the northeast shore, July 17.
374. *Bostrichus armiger* Lec. One specimen found on a board, on the northeast shore, June 22.

375. *Bostrichus truncaticollis* Lec. One specimen found crawling on a log, near the northeast shore.

Cioidae.

376. *Cis fuscipes* Mellié. One specimen taken on the willow, on the northeast shore, June 21.

Lucanidae.

377. *Lucanus dama* Thunb. Two female specimens found on a log, near the southwest beach, June 21. Two, a male and a female, taken on the sand near a log, on the southeast beach, July 17.
378. *Lucanus placidus* Say. Three specimens found on the south beach of Little Charity, June 25. Three (two males and a female) taken on a log, near the lighthouse, the night of June 21.
379. *Dorcus parallelus* Say. Two specimens caught near the lighthouse, night of June 23.
380. *Platycerus quercus* Web. One specimen taken on a log, on the northeast shore, June 23.
381. *Platycerus depressus* Lec. Two specimens found crawling on logs, near the northeast beach, June 25.
382. *Passalus cornutus* Fab. A dead specimen picked up from the washup on the northeast beach, by Captain McDonald, in August.

Scarabaeidae.

383. *Canthon nigricornis* Say. Two specimens found near the pig-pen, June 25.
384. *Canthon laevis* Drury. One specimen taken under a board, near the northeast beach, July 17.
385. *Copris anaglypticus* Say. Three specimens found crawling on the sand, on the northeast beach, June 24.
386. *Ataenius cognatus* Lec. Six specimens found in fungi, near the southwest shore, June 22. One taken on the steps of the lighthouse, July 17.
387. *Aphodius fossor* Linn. One specimen found crawling on the ground, near the pig-pen, June 25.
388. *Aphodius hamatus* Say. One specimen found on the sand, on the northeast shore, June 20. One found under a board, on the northeast shore, July 17.
389. *Aphodius fimetarius* Linn. Three specimens taken under a board, at the pig-pen, July 17.
390. *Aphodius ruricola* Melsh. One specimen found on the sand, on

the northeast shore, June 20. One found crawling on the sand, on the northeast shore, July 17.

391. *Aphodius foetidus* Fab. One specimen taken on the sand, on the northeast beach, June 21.

392. *Aphodius inquinatus* Hbst. One specimen found on the ground, near the pig-pen, June 22.

393. *Ochodaeus musculus* Say. One specimen taken on the sand, on the northeast beach, June 23.

394. *Bolboceras lazarus* Oliv. One specimen taken under the debris, on the northeast shore, July 17.

395. *Hoplia trifasciata* Say. Two females and one male specimens taken in the blossoms of wild rose, near southwest shore, June 25.

396. *Dichelonycha subvittata* Lec. Eight specimens found on the leaves of basswood and birch, near the northeast shore, June 20. Common.

397. *Dichelonycha albicollis* Burm. Six specimens taken on leaves of white and Norway pine, near the lighthouse, June 20. Four taken by beating a pine, near the southwest shore, July 17. Four taken on a pine, on the southwest shore, July 24. Very common.

398. *Serica vespertina* Gyll. Two specimens found on a log, on the northeast beach, June 23.

399. *Serica iricolor* Say. Two specimens found in cells formed in damp sand under a board, on the northeast beach, June 25. Two picked up, on the path to the lighthouse, July 17.

400. *Serica tristis* Lec. Two specimens taken, on the beach of the northeast shore, June 20.

401. *Serica sericea* Ill. Four specimens found on the sand, on the northeast beach, June 21.

402. *Serica intermixta* Blatchly. Four specimens found on the sand, on the northeast beach, June 21. Ten found on a log, on the northeast beach, June 23. Two found in cells in damp sand, under a board, on the northeast shore, July 17.

403. *Serica carinata* Blatchly. Two specimens found under a board, on the northeast beach, July 17.

404. *Macrodactylus subspinosus* Fab. Four specimens found on wild grape and wild rose blossoms, on the northeast shore, June 20. Very common.

405. *Diplotaxis sordida* Say. One specimen found in a cell in the damp sand under a board, on the northeast shore, June 25. Three taken in a lantern trap, in the woods, near the lighthouse, July 22.

406. *Lachnosterna nova* Smith. Two specimens taken in a lantern trap, in the woods, near the lighthouse, June 26.

407. *Lachnosterns gracilis* Burm. Four specimens found on the leaves of basswood, on the northeast shore, July 22.

408. *Lachnosterna fusca* Froh. Three specimens found on willows, near the northeast shore, June 22.

409. *Lachnosterna rugosa* Melsh. Two specimens taken on the willows, on the northeast shore, June 22. One taken in a lantern trap, in the woods, near the lighthouse, June 26.

410. *Lachnosterna albina* Burm. Four specimens found crawling, on the northeast beach, near the lighthouse. Three found dead in a washup, on the northeast beach, June 23.

411. *Anomala pubcsens* Blatchly. One specimen found in the blossom of a wild rose, near the southwest shore, June 26.

412. *Strigoderma arboricola* Fab. Sixteen specimens taken while flying in a patch of reeds, growing in the damp sand, near the southwest shore. They were fairly common on the blossoms of the meadow rose, near the southwest shore, June 23.

413. *Pelidnota punctata* Linn. Three specimens taken on a wild grape vine, along the path near the lighthouse, July 17.

414. *Cotalpa lanigera* Linn. Two specimens found crawling on the sand, of the northeast beach; two on willows, near the northeast beach, and four dead in a washup, on the northeast beach, June 22.

415. *Ligyrus gibbosus* DeG. One specimen taken while flying over dry land, near the northeast beach, and one found on the ground, near the pig-pen, July 17.

416. *Ligyrus relictus* Say. Six specimens found crawling on the sand, near the northeast beach, June 22. Two taken in cells made in damp sand under boards, on the northeast beach, June 25. Two taken on the wing, near the lighthouse, night of June 26. Four found crawling on the sand, on the northeast beach, July 17.

417. *Aphonus tridentatus* Say. One specimen taken while flying over the sand, on the northeast shore, July 17.

418. *Xyloryctes satyrus* Fab. One male specimen found crawling on the dead leaves on the ground, in rather open woods chiefly paper birch, many of them dead and decaying, near center of the island, June 25. Three male specimens found crawling on the ground near the bank, on the northeast shore, July 17. No females were found.

419. *Euphoria fulgida* Fab. Two specimens found on the branches of a willow, near the northeast shore, July 17.

420. *Euphoria inda* Linn. One dead specimen picked up on the sand,

near the water's edge, northeast shore, June 21. One taken on the sand, of the northeast beach, June 22.

421. *Trichus affinis* Gory. Six specimens taken in the blossoms of the meadow rose, near the southwest shore, June 24.

422. *Trichus viridulus*. Two specimens found in the blossoms of a meadow rose, near the northeast shore, June 20.

423. *Parandra brunnea* Fab. Four specimens found working in dead wood of a hollow oak tree, near the southwest shore, July 17.

Cerambycidae.

424. *Orthosoma brunneum* Forst. Two specimens taken in a lantern trap in the woods, near the lighthouse, July 17. Several taken in a washup, on the northeast shore, July 17. One taken on the screen at the lighthouse, July 21.

425. *Prionus laticollis* Drury. One specimen found crawling up from the edge of the water, on the northeast beach, July 17.

426. *Tragosoma harrissi* Lec. Two specimens found on a pine log, on the northeast beach, June 22. Two taken on a pine log, near the northeast beach, July 17.

427. *Asemum moestum* Hald. One specimen taken on a log, near the northeast beach, July 17.

428. *Criocephalus agrestis* Kirby. One specimen found crawling on a log, near the northeast beach, June 25.

429. *Criocephalus obsoletus* Rand. Two specimens taken, on the walk at the lighthouse, night of June 24. One taken in a lantern trap in the woods, near the lighthouse, June 26.

430. *Physocnemum brevilineum* Say. One specimen found running on a log, near the northeast shore, June 26.

431. *Chion cinctus* Drury. One specimen taken, on the wall of the lighthouse, June 24.

432. *Chion cinctus* var. *garganicus* Fab. One specimen taken in the blossoms of a swamp rose, on the edge of the pond, July 17.

433. *Elaphidion villosum* Fab. One specimen taken by beating the branches of a red oak, near the southwest shore, June 26

434. *Elaphidion unicolor* Rand. One specimen taken on a dead branch of a red oak, near the southwest shore, June 26.

435. *Elaphidion parallelum* Newm. One specimen found on an oak, near the lighthouse, July 17.

436. *Molorchus bimaculatus* Say. Six specimens found on the blossoms of red-stemmed dogwood, near the northeast shore, June 26.

437. *Purpuricenus humeralis* Fab. One specimen taken by beating a yellow oak, near the southwest shore, June 23.

438. *Calloides nobilus* Harris. One specimen taken by beating a small oak, near the northeast shore, June 23. One found under debris, near the edge of the water, on the northeast beach, July 17.

439. *Arhopalus fulminans* Fab. Three specimens found on an oak, near the lighthouse, June 20.

440. *Xylotrechus sagittatus* Germ. One specimen taken, on the outside wall of the lighthouse, July 17.

441. *Xy'otrechus undulatus* Say. One specimen taken on an oak, near the lighthouse, June 20.

442. *Clytanthus ruricola* Oliv. Two specimens found in the blossoms of the meadow rose, near the northeast shore, June 21.

443. *Cyrtophorus verrucosus* Oliv. Two specimens taken on the blossoms of red-stemmed dogwood, near the northeast shore, June 26.

444. *Cyrtophorus insinuans* Casey. Two specimens found in the blossoms of red-stemmed dogwood, on the northeast shore, June 23. Four found in the flowers of Jersey tea, in the woods, near the northeast shore, July 17.

445. *Acmaeops bivittata* var. *nigripennis* Lec. One specimen taken on the flowers of red-stemmed dogwood, on the northeast shore, June 23.

446. *Acmaeops proteus* Kirby. Three specimens taken on a log, within a foot of space and the only specimens found on the island, on the northeast shore, June 24.

447. *Acmaeops pratensis* Laich. One specimen found on a window-screen, attracted by the light in the lighthouse, June 23.

448. *Ballamira scalaris* Say. One specimen found crawling on a log, on the northeast beach, June 24.

449. *Gaurotes cyanipennis* Say. One specimen found on a log, on the southwest shore, June 22.

450. *Strangalia luteicornis* Fab. Four specimens taken on the flowers of red-stemmed dogwood, near the northeast shore, June 26.

451. *Typocerus velutinus* Oliv. Four specimens taken on the flowers of Jersey tea, near the path to the lighthouse, July 17.

452. *Leptura exigua* Newm. One specimen taken on the flowers of red-stemmed dogwood, on the northeast shore, June 23.

453. *Leptura subargentata* Kirby. One specimen taken on the flowers of red-stemmed dogwood, on the northeast shore, June 21.

454. *Leptura canadensis* Oliv. One specimen taken by beating branches of pine, near the northeast shore, June 22.

455. *Leptura vagans* Oliv. One specimen taken on the flowers of Jersey tea, near the path to the lighthouse, July 17.

456. *Leptura vittata* Oliv. One specimen taken on the flowers of red-stemmed dogwood, near the northeast shore, June 20.

457. *Leptura pubera* Say. Five specimens taken on the flowers of red-stemmed dogwood, near the northeast shore, June 26.

458. *Psenocerus supernotatus* Say. Four specimens taken on the flowers of red-stemmed dogwood, near the northeast shore, June 26.

459. *Monohammus titillator* Fab. One specimen taken on a pine log, on the southwest shore, June 22.

460. *Monohammus titillator* var. *carolinensis* Oliv. One specimen found on the trunk of a pine, near the southwest shore, July 17.

461. *Monohammus scutellatus* Say. One specimen taken on the trunk of a pine, near the southwest shore, June 22. Common on the mainland.

462. *Monohammus confusor* Kirby. One specimen found crawling on a log, on the northeast shore, June 23.

463. *Leptostylus macula* Say. One specimen taken on the outside wall, of the lighthouse, July 17.

464. *Liopus fascicularis* Harr. Two specimens found by beating a dead branch of a yellow oak, near the southwest shore, June 24. One found on a branch of a dead oak, near the southwest shore, July 17.

465. *Liopus cinereus* Lec. Three specimens taken by beating the dead branch of an oak, near the southwest shore, June 24.

466. *Urographis fasciatus* DeG. One specimen found on a window-screen, attracted by the light from the lighthouse, June 20.

467. *Lepturges querci* Fitch. One specimen found on a log, near the northeast shore, July 17.

468. *Hyperplatys aspersus* Say. One specimen taken on a branch of basswood, on the path to the lighthouse, June 26.

469. *Hyperplatys maculatus* Hald. Two specimens taken by beating a dead branch of basswood, near the southwest shore, June 24.

470. *Acanthocinus obsoletus* Oliv. One specimen found by beating a red oak, near the southwest shore, July 17.

471. *Saperda calcarata* Say. One specimen taken on the trunk of a poplar, near the path to the lighthouse, July 19.

472. *Saperda calcarata* var. *adspersa* Lec. One specimen taken on the trunk of a poplar, near the path to the lighthouse, July 19.

473. *Saperda mutica* Say. Eight specimens taken by beating the willows, near the southwest shore, June 23.

474. *Saperda moesta* Lec. Four specimens found by beating balsam poplar, near the southwest shore, June 25.

475. *Oberea tripunctata* Swed. One specimen taken by beating willows, near the southwest shore, June 26.
476. *Tetraopes tetraophthalmus* Forst. Four specimens taken on milkweeds, near the lighthouse, July 17.

Chrysomelidae.

477. *Donacia harrisii* Lec. One specimen found on sedges, near the southwest shore. Eight specimens taken on the sedges, near the southwest shore, July 17.
478. *Donacia palmata* Oliv. Four specimens taken on the leaves of water lilies in the pond, near the southwest shore, June 24.
479. *Donacia distincta* Lec. Two specimens found on sedges near the southwest shore, June 25.
480. *Donacia subtilis* Kunze. Five specimens taken on sedges, near shore, Snake Point, July 17.
481. *Donacia cincticornis* Newm. Two specimens taken on the leaves of water lillies, in the pond, near the southwest shore, July 17.
482. *Donacia pusilla* Say. Two specimens taken on arrow-head, near the southwest shore, June 21.
483. *Haemonia nigricornis* Kirby. One specimen found under a board, on the southwest beach, June 24.
484. *Babia 4-guttata* Oliv. One specimen taken by beating willows near Snake Point, southwest shore, July 17.
485. *Pachybrachys elegans* Blatchly. One specimen found by beating willow, near the northeast shore, June 23.
486. *Xanthonia villosula* Melsh. One specimen taken by beating an oak, near the southwest shore, June 24.
487. *Adoxus vitis* Linn. Six specimens found on flowers of red-stemmed dogwood, near the northeast shore, June 21.
488. *Chrysochus auratus* Fab. Two specimens found on leaves of milkweed, near the lighthouse, June 22.
489. *Metachroma angustula* Crotch. One specimen found on the sand beneath a willow near the southwest shore. One found in lantern trap in woods, near the lighthouse, June 25.
490. *Metachroma interrupta* Say. Four specimens taken on willow leaves, near the southwest shore, June 22.
491. *Metachroma pallida* Say. Two specimens taken on willows, near southwest shore, June 22.
492. *Labidomera clivicollis* Kirby. Two specimens taken on milkweed, near the southwest shore, June 26.
493. *Leptinotarsa decemlineata* Say. Two specimens taken on the foliage of the night-shade, *Solanum dulcamara*. Fifteen or more

of the larvae were feeding on the plant, near the northeast shore, June 21. Several picked up dead on the beach.

494. *Calligrapha elegans* Oliv. Two specimens taken by beating willows, near the southwest shore, July 17.

495. *Calligrapha lunata* Fab. Two specimens taken on the wing, near the lighthouse, June 22.

496. *Calligrapha scalaris* Lec. One specimen taken on the under side of a board, on the northeast beach, June 24. One by beating willow, near the southwest shore, June 26. Two by beating birch, near the northeast shore, July 17.

497. *Calligrapha multipunctata* Say. Three specimens taken by beating branches of willows, near the southwest shore, July 17.

498. *Calligrapha multipunctata* var. *bigsbyana* Kirby. Four specimens taken on the leaves of willow, near the southwest shore, June 20.

499. *Gastroidea polygoni* Linn. Two specimens taken on larger blue-flag, *Iris versicolor*, near the southwest shore, July 17.

500. *Phyllobrotica decorata* Say. One specimen taken by beating the willows, at the pond, June 23.

501. *Phyllobrotica limbata* Fab. One specimen found by beating the willows, at the pond, June 23.

502. *Diabrotica vittata* Fabr. Five specimens taken by beating the willows, near the southwest shore, June 24. Three by beating a thorn-tree, Crataegus, near the lighthouse, July 17.

503. *Galeruca marginella* Kirby. One specimen taken by beating the willows, near the southwest shore, July 17.

504. *Oedionychis vians* Ill. Three specimens taken by beating the willows, near the southwest shore, June 25.

505. *Disonycha pennsylvanica* Ill. One specimen taken by beating the willows, near the southwest shore, June 26.

506. *Disonycha triangularis* Say. One specimen found by beating the willows, near the northeast shore, July 17.

507. *Disonycha xanthomelaena* Dalm. One specimen found feeding on pig-weed, *Chenopodium album*, near the southwest shore, June 24.

508. *Haltica bimarginata* Say. Two specimens taken on wild grape leaves, near the southwest shore, June 21. One found by beating willows, near the southwest shore, July 17.

509. *Haltica ignita* Ill. Ten specimens taken by beating wild grape vines, near the northeast shore, June 23. One on wild grape June 24.

510. *Haltica aenescens* Blatchly. Four specimens taken on wild grape vine, near the lighthouse, July 17.

511. *Chalepus rubra* Weber. Two specimens taken by beating the willows, near the southwest shore, June 23

512. *Chalepus nervosa* Panz. One specimen taken on the flowers of red-stemmed dogwood, near the northeast shore, June 23.

513. *Chelymorpha argus* Hbst. One specimen found on a milkweed, near the southwest shore, July 17.

514. *Bruchus nigrinus* Horn. Two specimens found under cured and dried milkweed, near the lighthouse, July 17.

Tenebrionidae.

515. *Nyctobates pennsylvanica* DeG. Two specimens found under the bark of a dead oak, near the south shore, June 23. Three taken under the bark of a dead oak, near the northeast shore, July 17.

516. *Nyctobates barbata* Knoch. One specimen taken under the bark of a dead oak, near the center of the island, June 26.

517. *Iphthimus opacus* Lec. Five specimens taken on logs, on the northeast shore, and a few dead ones washed up on the beach, June 21. Four taken on a log, near the northeast shore, July 17.

518. *Upis ceramboides* Linn. One specimen taken on the bark of a pine log, on the northeast beach, June 21. Four taken in the fungi on a log, near the southwest shore, June 25. One on a log, near the lighthouse. July 17.

519. *Haplandrus concolor* Lec. Three specimens found under the bark of a dead oak, near the southwest shore, June 22. Four found on the shaded sides of timber, on the southwest shore, June 26.

520. *Xylopinus saperdioides* Oliv. One specimen found under the bark of a dead oak, on the northeast shore, June 21. One taken under the bark of a dead oak, on the southwest shore, June 26. One taken under the bark of a dead oak, near the southwest shore, July 17.

521. *Tenebrio obscurus* Fab. Three specimens found crawling on logs, on the northeast beach, June 22. One taken under the bark of a dead oak, near the northeast shore, June 26.

522. *Tenebrio molitor* Linn. One specimen found under the bark of an oak log, washed up by the waves, on the southwest shore, July 17. One under bark of dead oak, near the southwest shore, July 17.

523. *Tenebrio castaneus* Knock. Three specimens found under the bark of a dead oak, near the southwest shore, June 22. One found under boards, on the northeast beach.

524. *Tenebrio tenebrioides* Beauv. Two specimens found under the bark of a dead oak, near the southwest shore, June 22. Two living and a dead one found under the bark of an oak, near the center of the island, June 26. One found under the bark of a log, washed up in the southwest shore, July 17.
525. *Blapstinus interruptus* Say. One specimen found under a board, on the northeast beach, July 17.
526. *Diaperis maculata* Oliv. Six specimens found in fungi on a log, near the southwest shore, June 26.
527. *Arrhenoplita bicornis* Oliv. Two specimens found in dried fungi on a dead trunk of a tree, near the northeast shore, June 23.
528. *Platydema flavipes* Fab. One specimen taken at sugar lure, on a tree in the woods, near the lighthouse, June 26.
529. *Platydema americanum* Lap. One specimen taken at a sugar lure, on a tree at the path, near the lighthouse, night of July 19.
530. *Platydema laevipes* Hald. Two specimens taken on the trunk of a red oak, near the lighthouse, June 22.
531. *Hypophloeus parallelus* Melsh. One specimen taken in gallery of bark beetle in a pine tree, near the southwest shore, July 17.
532. *Bolctotherus bifurcus* Fab. Three specimens taken in dried bracket fungi, near the southwest shore, June 24. Several found in bracket fungi, near the northeast shore, July 17.
533. *Boletophagus corticola* Say. One specimen taken in a lantern trap, in the woods near the lighthouse, June 25. Two taken under the bark of a pine, near the path to the lighthouse, July 17.
534. *Bolctophagus depressus* Rand. One specimen found under a log, near the northeast beach, June 25.
535. *Meracantha contracta* Beauv. One specimen found on the trunk of a tree, near the lighthouse, night of June 26.

Cistelidae.

536. *Allecula punctulata* Melsh. Two specimens taken at a sugar lure on trees near the lighthouse, night of July 17. One found under a board, on the northeast shore, July 17.
537. *Allecula atra* Say. Four specimens taken on flowers of red-stemmed dogwood, near the northeast shore, June 21.
538. *Hymenorus pilosus* Melsh. One specimen found in fungi, on trunk of tree, near the southwest shore, June 23.
539. *Hymenorus obscurus* Say. Two specimens taken on the flowers of Jersey tea, near the path running to the lighthouse, July 17.
540. *Hymenorus densus* Lec. One specimen found in fungi, growing on a tree near the pond, southwest shore, July 17.

541. *Isomira sericea* Say. Three specimens found crawling on a log, on the northeast beach, June 23. One taken on the blossoms of red-stemmed dogwood, near the northeast shore, July 17.

542. *Isomira quadristriata* Coup. One specimen taken on a board, near the northeast shore, July 17. Three taken on the willows, near the southwest shore, June 21.

543. *Isomira similis* Blatchly. One specimen found under a board, on the northeast shore, July 17.

Melandryidae.

544. *Pisenus humeralis* Kirby. One specimen found under the bark of a dead oak, near the center of the island, June 26. One taken in fungi on a log, near the southwest shore, July 17.

545. *Penthe obliquata* Fab. One specimen found crawling on a log, near the southwest shore, July 16.

546. *Synchroa punctata* Newm. One specimen found on the blossoms of red-stemmed dogwood, near the northeast shore, June 21.

547. *Eustrophus confinis* Lec. One specimen found in fungi growing on a log, near the southwest shore, June 25.

548. *Melandrya striata* Say. One specimen taken by beating the dead branches of basswood, near the southwest shore, June 24.

549. *Enchodes sericea* Hald. One specimen taken on a log, on the northeast shore, June 20. One taken by beating the blossoms of dogwood, near the northeast shore, June 26.

550. *Serropalpus barbatus* Schall. Two specimens taken on logs, on the northwest shore, June 20.

551. *Hallomenus debilis* Lec. Two specimens found under a log, on the northeast beach, June 21.

552. *Mycterus scaber* Hald. Two specimens taken under cut and dried milkweed, on the northeast shore, near the lighthouse, July 17.

Pythidae.

553. *Salpingus virescens* Lec. Two specimens taken under debris, on the southwest shore, July 17.

Mordellidae.

554. *Anaspis rufa* Say. Four specimens found in flowers of red-stemmed dogwood, near the northeast shore, June 26. Three taken under cut milkweed, on the northeast shore, near the lighthouse, July 17.

555. *Mordellistena biplagiata* Helm. Six specimens taken on the flowers of dogwood, near the northeast shore, June 23.

Anthicidae.

556. *Anthicus cervinus* Laf. One specimen found under a board, on the northeast beach, June 23.

Pyrochroidae.

557. *Dendroides bicolor* Newm. One specimen found under the bark of a dead oak along the path, near the center of the island, June 20.

Meloidae.

558. *Macrobasis unicolor* Kirby. One specimen taken on a grass stem, near the northeast shore, June 20. One taken on a willow, near the southwest shore, July 17.

559. *Epicauta cinerea* Forst. One specimen taken by beating the willows, on the northeast shore, July 17.

560. *Epicauta ferruginea* Say. Two specimens found by beating willows, near the northeast shore, July 17.

561. *Epicauta marginata* Fab. Two specimens taken by beating willows, near the southwest shore, July 17.

Otiorhynchidae.

562. *Otiorhynchus sulcatus* Fab. One specimen taken on the willows, near the southwest shore, July 17.

563. *Otiorhynchus ovatus* Linn. Three specimens taken on the willows, near the southwest shore, June 22.

564. *Pandeletejus hilaris* Hbst. One specimen taken on a branch of an oak, at the north end of the island, June 20. One taken on a branch of an oak, near southwest shore, July 17.

Curculionidae.

565. *Phytonomus punctatus* Fab. Two specimens found under boards, near the northeast shore, June 22. One taken on a board, near the northeast beach, July 17.

566. *Lepyrus geminatus* Say. Three specimens taken on branches of willows, on the northeast shore, June 20. Four taken on the balm of Gilead and willows, on the southwest shore, June 20. Four taken on the balm of Gilead and willows, on the southwest shore, June 23. They are killing willows, etc., by the larvae boring near the roots.

567. *Listronotus sordidus* Gyll. Two specimens found on the under side of a board, on the northeast shore July 17.

568. *Listronotus tuberosus* Lec. One specimen taken by beating the branches of white pine, near the southwest shore, June 26.

569. *Listronotus squamiger* Say. One specimen found crawling on a log, on the northeast shore, June 25.

570. *Listronotus callosus* Lec. Two specimens taken on a log, on the southwest shore, June 22. Four taken by beating willows, on the southwest shore, June 23.

571. *Listronotus inaequalipennis* Boh. Three specimens found crawling on logs, on the northeast shore, July 17.

572. *Listronotus caudatus* Say. Sixteen specimens found on the undersides of boards, on the northeast beach, July 17.

573. *Listronotus* nebulosus Lec. Two specimens found on a hawthorn tree, near the lighthouse, July 17.

574. *Listronotus frontalis* Lec. One specimen found crawling on a board, on the northeast shore, July 17.

575. *Hyperodas* (*Macrops*) *sparsus* Say. Three specimens found crawling on a log, on the northeast beach, July 17.

576. *Pachylobius picivorus* Germ. One specimen found under a board, on the northeast beach, July 17.

577. *Pissodes strobi* Peck. One specimen found on a pine log, near the northeast shore, July 17.

578. *Hylobius pales* Hbst. One specimen taken on a log, on the northeast shore, June 23. One found crawling on the rocks, near the northeast shore, July 17.

579. *Hylobius confusus* Kirby. Eight specimens found on pine logs and boards, on the northeast shore, June 21.

580. *Stephanocleonus plumbeus* Lec. One specimen found on a willow, near the northeast shore, June 21.

581. *Dorytomus laticollis* Lec. Ten specimens found crawling on logs and boards on the northeast shore, June 21.

582. *Dorytomus laticollis* Lec. var. One specimen found crawling on a rock, on the northeast shore, June 23.

583. *Dorytomus brevicollis* Lec. Six specimens found on logs and boards, on the northeast beach, July 17.

584. *Grypidius equiseti* Fab. One specimen found on a stone, near the northeast shore, June 23.

585. *Erycus puncticollis* Lec. Two specimens found crawling on rocks, on the northeast shore, July 17. Four taken on rocks, underside of boards.

586. *Simcronyx griseus* Lec. One specimen taken on the flowers of red-stemmed dogwood, near the northeast shore, July 17.

587. *Smicronyx corniculatus* Fab. One specimen found near the water edge, on the northeast shore, July 17.

588. *Lissorhoptrus simplex* Say. One specimen taken on a log, near the southwest shore, July 17.

589. *Bagous magistar* Lec. One specimen taken by beating willows, near the southwest shore, July 17.

590. *Magdalis olyra* Hbst. One specimen taken on a log on the northeast beach, June 21.

591. *Tachypterus quadrigibbus* Say. One specimen taken on a log, near the northeast beach, July 17.

592. *Gymnetron teter* Fab. One specimen found by beating a birch, near the northeast shore, July 17.

593. *Nanus uniformis* Boh. One specimen found crawling on a rock, on the northeast shore, June 25.

594 *Conotrachelus posticatus* Boh One specimen found on a board, near the northeast beach, July 17. One found on a board, near the southwest beach, July 17.

595. *Conotrachelus nenuphar* Hbst. One specimen taken on a willow, near the southwest shore June 22.

596. *Conotrachelus anaglypticus* Say. One specimen taken on the blossoms of red-stemmed dogwood, near the northeast shore, June 24. One taken on a willow, near the southwest shore, July 17.

597. *Pseudomus truncatus* Lec. One specimen taken by beating the willows, near the northeast shore, June 24.

598. *Pseudomus inflatus* Lec. Two specimens found by beating the willows, near the northeast shore, June 23.

599. *Tyloderma aereum* Say. One specimen taken by beating birch, near the northeast shore, June 19.

600. *Cryptorhynchus bisignatus* Say. One specimen taken on a willow, near the northeast shore, June 21. Three found on the under side of a board, on the northeast shore, June 24. Five found on a board, near the northeast beach, July 17.

601. *Cryptorhynchus fallax* Lec. Two specimens found on the under side of a board, on the northeast beach, July 17. One taken on a wild grape, northeast shore, near the lighthouse.

602. *Cryptorhynchus lapathi* Linn. Two specimens found on stones, near the northeast beach, June 25.

603. *Acoptus suturalis* Lec. One specimen taken by beating willows, near the northeast shore, June 24.

604. *Cocliodes acephalus* Say. One specimen taken on milkweed leaves, near the northeast shore, July 17.

605. *Centrinus prolixus* Lec. One specimen taken on wild grape, near the northeast shore July 17.

606. *Balaninus uniformis* Lec. Three specimens found on a log, near the northeast shore, July 17.

607. *Balaninus nasicus* Say. One specimen found crawling on a rock, on the northeast shore, July 19.

Brenthidae.

608. *Eupsalis minuta* Drury. One specimen found under the bark of a dead oak, near the southwest shore, June 20. One found under the bark of a dead oak, near the center of the island, June 26.

Calandridae

609. *Sphenophorus striatipennis* Chilt. Two specimens found on boards, on the northeast beach, June 24.
610. *Sphenophorus aequalis* Syll. One specimen found under a board, on the northeast beach, June 22.
611. *Sphenophorus zeae* Walsh. Two specimens found crawling on rocks, on the northeast beach, June 24.
612. *Sphenophorus venatus* Say. Ten specimens found on rocks, undersides of boards and logs, along the northeast beach, July 17.
613. *Sphenophorus ochreus* Lec. One specimen taken on the side of a log, on the northeast beach, June 20. Two taken on the underside of a board, June 24. One taken on a rock, on the northeast shore, July 16.
614. *Spenophorus pertinax* Oliv. Six specimens found crawling on rocks, boards and logs, on the northeast shore, July 16.
615. *Sphenophorus robustus* Horn. One specimen found crawling on a stone, on the northeast beach, June 24.
616. *Sphenophorus costipennis* Horn. Six specimens found on logs, boards, also on sedges, on the northeast beach, June 21.
617. *Sphenophorus cariosus* Oliv. Two specimens found on the underside of boards, on the northeast beach, July 17.
618. *Sphenophorus sculptilis* Uhler. Three specimens found on the underside of boards, on the northeast shore, July 17.
619. *Sphenophorus villosiventris* Chitt. Two specimens found under a board, on the northeast beach, June 24.
620. *Sphenophorus cultellatus* Horn. Four specimens taken on pine logs, on the northeast shore, June 22.
621. *Cossonus concinnus* Boh. Two specimens found crawling on a pine log, on the northeast shore, June 21.

Scolytidae.

622. *Monarthrum mali* Fitch. One specimen found in a lantern trap, in the woods near the lighthouse, June 25.

Anthribidae.

623. *Cratoparis lunatus* Fab. Two specimens taken on a pine trunk, near the northeast shore, June 21.

RESULTS OF THE SHIRAS EXPEDITIONS TO WHITEFISH POINT, MICHIGAN: FISHES.

T. L. HANKINSON.

RESULTS OF THE SHIRAS EXPEDITIONS TO WHITEFISH POINT, MICHIGAN: FISHES.

T. L. HANKINSON.

The fish of the Whitefish Point region, Chippewa County, Michigan, and the organisms ecologically related to them were studied in the field between July 29, 1913, and August 31, 1913, by the writer who was sent there for this purpose by the Museum of Zoology of the University of Michigan. The investigations form a part of the biological survey of the region which is being made by the Museum and the Michigan Geological and Biological Survey with the support of Hon. George Shiras 3d.

As it is believed that the animal life of any area cannot be understood without a knowledge of the environmental conditions and the interrelations of the faunas and the habitat conditions, an attempt was made to consider the fish of the Whitefish Point region from this ecological standpoint.

No studies have heretofore been made of the fish of this part of Michigan, and very few notes relating to them can be found in literature. Lists of plantings at Whitefish Point, statistics, and notes chiefly of commercial interest on the fish there, are given in the publications of the United States Bureau of Fisheries, especially in those entitled, "Distribution of Fish and Eggs," and also in the Reports of the Michigan Fish Commissioners. These show that the Lake Superior fishery at Whitefish Point is an old and important one. Milner (1872) says that this is one of the principal fisheries on Lake Superior. G. Brown Goode (1887) discusses the importance of the Whitefish Point Fishery and informs us that it first attained magnitude in 1870. Smith and Snell (1887) state that in 1866 fishermen from Sackett's Harbor, New York, caught fish, chiefly whitefish, there, which they salted and sent to Cleveland and Detroit. C. H. Moore (1893) says, "Located at Whitefish Point, are the most productive whitefish grounds anywhere to be found in Lake Superior," and again (1895) he states that the most important fishery upon Lake Superior is Whitefish Point, and "from this point, large and complete outfits of pound and gill nets are fished, and the catch is mainly whitefish and trout, about one-half of each variety."

GENERAL DESCRIPTION OF THE WHITEFISH POINT REGION.

The Whitefish Point Region is considered by this survey to include that part of Chippewa County which lies north of the Shelldrake River and east of a line drawn from this to the Chippewa-Luce County line at Lake Superior (Plate XI). It lies between 46° 40′ and 46° 46′ north latitude and between 84° 7′ and 85° 15′ west longitude.

In the short time spent in the field at Whitefish Point all of its bodies of water could not be visited so special attention was given to the fish near Vermilion, this place being headquarters for the work. This limited region, fortunately, was very diversified and appeared to have, within a radius of two miles, fish habitats typical of the whole area (Fig. 3).

Topography.

Country of two distinct kinds exists in the Whitefish Point Region: (1) forested upland with sandy soil, recently burnt over almost everywhere, (2) lowland with tree-covered sand ridges running in general parallel with the Lake Superior shore and separating large areas of low and level open marsh and wooded swamp land containing a number of small lakes. The upland and lowland areas are sharply demarcated by a steep slope or bluff. This is about seventy-five feet high near Vermilion where it runs in a general east and west direction and is located nearly a mile back from Lake Superior. Some distance east of Vermilion it is much farther from the lake than this; and west of this place, it approaches within a few hundred feet of the lake. The bluff represents the shore line of the old Lake Nipissing. The lowland about Vermilion was thus once covered by the water of Lake Nipissing, so it is newer than that of the more remotely submerged upland. Along Lake Superior lies a broad, sandy beach with scant vegetation and much drift strewn upon it and with a pebble zone several feet wide close to the water's edge (Plates XII, XIII and XIV). The shoal is here broad with a firm sandy bottom, without evident plants, and with a submerged pebble zone in the shallowest part. The small lakes of the belt of marsh land (called marsh lakes in this paper) are surrounded by sedge marshes and wooded swamps; they lie with their long axes generally parallel with the shore of Lake Superior and the sand ridges. They are all shallow, probably nowhere over seven feet and in most places less than three feet (Plate XVII and Fig. 3). The Shelldrake River cuts through the upland some two miles south of Vermilion, expanding into a lake, called Shelldrake Lake (Plate XI, XXV and Fig. 3). Conditions about this lake, except a few marked vegetal differences, are quite similar to those about the marsh lakes.

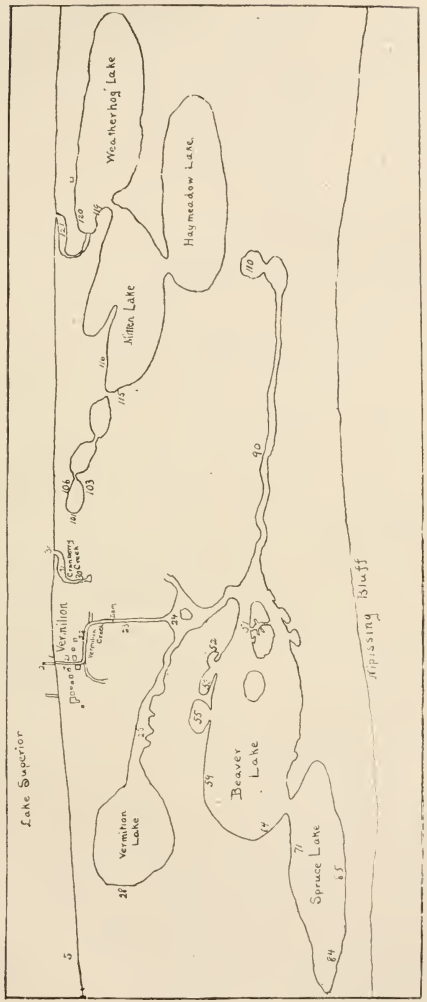

Weatherhog Lake
Haymeadow Lake
Mitten Lake
Vermilion
Vermilion Lake
Beaver Lake
Spruce Lake
Nipissing Bluff
Lake Superior

Figure 3

Vegetation.

The Whitefish Point region has a rich and varied vegetation. This has been little interfered with on the lowland, but much of the upland has been burned over, and the forests have been cut off, so that the plant life retains little of its primitive character. One small area of several acres near Vermilion still has a thick, untouched growth of large pines (*Pinus strobus* and *Pinus resinosa*) and is an isolated relic of the great pine forest that once covered this region as well as much of the rest of northern Michigan. In other places, the upland has only small trees, prominent among which are spruces (*Picea* sp.), jack pines (*Pinus Banksiana*), birches (*Betula* sp.), alders (*Alnus* sp.), aspens (*Populus tremuloides* and *Populus grandidentata*), red oaks (*Quercus rubra*), maples (*Acer* sp.), all forming scattered growths or in a few places small forests or coppices. Tall pines exist here and there over the burned area, but their charred stubs are more numerous. Everywhere on this upland, there is an undergrowth, composed chiefly of oak ferns (*Phegopterus dryopterus*), blueberry (*Vaccinium* sp.), wintergreen (*Gaultheria* sp.), bearberry (*Arctostaphylos uva-ursi*), sarsaparilla (*Aralia* sp.), trailing arbutus (*Epigaea repens*), pearly everlasting (*Anaphalis*) and a number of other plants including many grasses and sedges. Reindeer moss (*Cladonia* sp.) and other lichens were abundant and very generally distributed.

The belt of lowland along Lake Superior, where marsh conditions are prevalent, has a vegetation very different from that of the upland just described, but the dry sand ridges have associations of plants very similar to those of the upland. Both the upland and the sand ridges support birches, aspens, alders, maples, red pines, and white pines as their most noticeable trees; and blueberries, huckleberries, wintergreens, and oak ferns form the chief undergrowth on the high ground as well as on the low ground. There are some plants, however, that while common on the sand ridges appear to be scarce or absent on the upland. These are: Balsam fir, (*Abies balsamea*), willows, (*Salix* sp.), service berry, (*Amalanchier canadensis*), wild cherry, (*Prunus* sp.), red osier dogwood, (*Cornus stolonifera*), raspberry, (*Rubus* sp.), low juniper, (*Juniperus communis depressa*), Labrador tea, (*Ledum* sp.), bunch berry (*Cornus canadensis*), dogbane (*Apocynum* sp.), pigeon berry, (*Phytolacca decandra*), beach pea (*Lathyrus maritimus*), skull cap (*Scutellaria* sp.), rattle snake plantain (*Epipactis* sp.), St. John's wort (*Hypericum* sp.), spotted touch-me-not (*Impatiens biflora*), squaw berry (*Vaccinium* sp.), and sand cherry (*Prunus pumila*). A number of other common plants were not determined; and there are many species on these ridges represented by but a few individuals in each case. One

of these is the red cedar (*Juniperus virginiana*). Many mosses and lichens were present here; the latter including some long pendant forms that made festoons among dead tree branches.

The low ground between the sand ridges has a large variety of plants, which are chiefly hydrophytic. In the small lakes, extensive carpets of stonewort (Characeae) are found in some places; in others, water weeds (*Elodea canadensis*) grew in patches on the bottom. Pondweeds thrived in the deeper parts of the lakes. Of these there are the oblong-leaved forms (*Potamogeton lucens* and *P. natans*) and the narrow, linear-leaved, grass-like pondweeds (*Potamogeton rutilis* and *P. heterophyllus*), commonly producing grayish green tufts up from the bottom. In places there are also many water milfoils (*Myriophyllum* sp.) and bladderworts (*Utricularia intermedia* and *U. vulgaris americana*). Yellow water lilies (*Nymphaea americana*) form patches of varying extent. Distinct zonal arrangements of pondweeds and water lilies are not present in these lakes, the plants occurring in irregular patches; indeed, water plants are not a conspicuous feature of these bodies of water, for, in most places, rooted plants are absent and the bottom is composed of loose muck or hard sand, neither of which appears favorable for rooted aquatic plants. Considerable algae were found in a number of places, but like the seed plants, were not generally distributed. They mostly form gelatinous masses (*Nostoc* sp., *Anabaena* sp., and *Rivularia* sp.) or green, floating scums, with filaments of several species intermixed, but with those of *Spirogyra fluviatilis* and *Zygnema* sp. predominating. Green tufts of *Vaucheria* filaments grew on the bottom at some stations.

Extensive sedge growths border the marsh lakes almost everywhere. In places the plants are in clumps so it is impossible to find a line separating lake and marsh (Plate XIX). Some plants taken from a typical shore growth proved to be *Carex lanuginosa*, *Dulichium arundinaceum*, and *Eleocharis* sp. Much moss, including *Sphagnum*, grows about the bases of the sedges in the wet marshes, as well as pitcher plants (*Sarracenia purpurea*) and cranberry (*Vaccinium Oxycoccus*). The latter is propagated in the Whitefish Point region and forms a very profitable industry there. A low shrub (*Myrica Gale*) thrives in large numbers in zones and patches about the edges of the lakes as well as in other parts of the marsh region. This plant is shown in Plates XVIII, XX and XXI. No attempt was made to identify all the marsh plants, and only a few other conspicuous ones will be mentioned. These are: cat-tails (*Typha latifolia*), blue flags (*Iris versicolor*), arrow head (*Sagittaria* sp.), bulrush (*Scirpus validus*), Cassandra (*Chamaedaphne* sp.), smart weed (*Polygonum Muhlenbergii*), bur-reed (*Sparganium curycarpum*), marsh bluebell (*Campanula aparinoides*), marsh five-

finger (*Potentilla palustris*), rosemary (*Andromeda* sp.), cotton grass (*Eriophorum virginicum*), and high huckleberry (*Gaylussacia* sp.). Willows formed patches and borders. Tamaracks (*Larix laricina*) with spruces formed thick swamps and also grew singly over the marsh. Many of these tamaracks were dead (Plate XVIII).

Where the marsh lakes touch tamarack or spruce-cedar swamps, their shores are wooded (Plate XXIIA). The oldest, thickest swamps and those with largest trees are near the Nipissing bluff. These are quite extensive near Vermilion and contain besides spruces many white cedars, with birches, maples, mountain ashes, and many tamaracks forming marginal growths. These swamps have wet, soggy floors or small pools or streams with hummocks, exposed roots, fallen trees or limbs. *Sphagnum* sp. and other mosses thrive here with many pitcher plants, ferns orchids and other forms. About the edges of these swamps, thick undergrowth is commonly present with such plants as high huckleberry, cotton grass, willows, sweet gale and rosemary conspicuous.

Invertebrates.

As with the plants, only those invertebrates most closely related to the fish life in an ecological way were given particular attention; these, of course, are those which are aquatic or have aquatic stages. Insects were observed in largest numbers. Some very noticeable ones are biting flies, about the size and general appearance of house flies, which are exceedingly numerous, much more so near Lake Superior. In appearance and behavior, they are like stable flies (*Stomoxys calcitrans*); and it is possible that they are this insect, since a specimen of the species was found in a small collection of insects made along the lake shore. Mosquitoes are very numerous, and they were most in evidence about the lowland marshes, toward evening. A few specimens collected proved to be *Culex sylvestris*, *Culex subcantans*, and *Anopheles quadrimaculatus*. A number of kinds of dragon-flies and damsel-flies, swarms of gnats, small, annoying tabanids, and many moths, and butterflies, were the most conspicuous of the aerial insects. On the water surface were gyrinids, water striders, and other insects with some spiders. On floating water lilies were seen leaf-eating beetles (*Donacea* sp.) and frequently large, slender, naked caterpillars (*Bellura* sp.), that eat the channels in these leaves and mine their petioles (Welch, 1914). Tiger beetles are common on Lake Superior beach. Some caught there are *Cicindella hirticollis*. Beneath the surface in the marsh lakes and in the beach ponds were found many insect larvae and some adults. A list of those collected is here given:

May-flies: *Heptagenia*.

Dragon-flies: *Aeschna* sp., *Gomphus* sp., *Tetragoneura* sp., *Somatochlora* sp., *Leucorhinia intacta* Hag., *Sympetrum* sp., *Ladonia exusta* Say, *Libellula pulchella* Drury, *Plathemis lydia* Drury, and *Enallagma* sp.

Aquatic Hemiptera: *Notonecta undulata* Say, *Corixa* sp., *Arctocorisa nitida* Lieb., *Arctocorisa interrupta* Say, *Lethocerus* sp., *Gerris remiges* Say, *Gerris rufoscutellatus* Latr., *Gerris marginatus* Say.

Alder flies: *Sialis* sp.

Aquatic Diptera: *Chironomus* sp., *Ceratopodon* sp.

Aquatic Coleoptera: *Dytiscus* sp., *Gyrinus ventralis* Kirby, *Gyrinus canadensis* Regimbart, *Dineutes nigrior* Rob.

Crustaceans were not found in noticeable numbers anywhere, yet entomostracans formed a prominent part of the food of small whitefish, herrings, suckers, sticklebacks, and perch that gathered in large numbers during calms on the Lake Superior shoal. The compact masses of entomostracans in the fish stomachs and intestines are of an orange color and frequently are evident through the body wall of an undissected fish. Analyses of the material revealed three genera and three species in the stomachs of the little fish examined; these are: *Bosmina longirostris, Diaptomus ashlandi,* and *Cyclops viridis brevispinosus.* Droppings of the fish were numerous on the shore at the water's edge, where they formed minute windrows, like orange-colored strings, thrown up by the gentle waves. The distribution of these small crustaceans was not studied, but they appeared very scarce in shallow water; none could be seen in water dipped up in a pail or bottle. The marginal shoal may not be the main feeding ground for the fish, which may be there for other reasons such as higher water temperature, or excess of oxygen. Entomostracans were also found in the stomachs of fish taken in bodies of water other than Lake Superior.

Crayfish were occasionally caught in the marsh lakes and were quite common in their outlet streams. *Cambarus virilis* was the only species found here, but of the two specimens taken in Shelldrake River, one was *Cambarus virilis* and the other *C. propinquus.* Amphipods could be picked from masses of aquatic plants drawn in by a net. Those taken were all *Hyalella knickerbockeri* (Bate) and *Eucrangonyx gracilis* (Smith). The former appear the most common and more generally distributed. Amphipods also were in Lake Superior for they were taken from the stomachs of Menominee whitefish. A few isopods, *Mancasellus tanax* (Smith), were found on plant debris from the marsh lakes.

Mollusks were found in numbers by the writer only in certain places. In a small, marsh-bordered bay of Beaver Lake (Station 55), many small bivalves could be taken by drawing the net through the thick

muck on the bottom. These were *Sphaerium rhomboideum* Say. They were taken in other parts of the marsh lakes, but nowhere were they found in such numbers as they were at Station 55. *Sphaerium simile* Say, was found in a collection from the marsh lakes. Three univalve mollusks, *Physa heterostropha* Say, *Planorbis antrosus striatus* Baker, and *Physa gyrina* Say, were incidentally collected with fish. *Physa gyrina* was found only in the Shelldrake River, and the others in marsh lakes and beach ponds west of Vermilion.

The margins of the shallow marsh lakes are favorable places for leeches. These creatures are ravenous, and much difficulty is experienced in keeping them from one's body while wading. The following leeches were taken by the writer in the region: *Placobdella rugosa* (Verrill), *Haemopsis marmoratus* (Say), *Macrobdella decora* (Say) Verrill, *Glossiphonia complanata* (Linn.) Johnston, *Erobdella punctata* (Leidy), and *Dina fervida* (Verrill).

Sponges, bright green in color, often formed extensive growths on submerged brush, roots, logs, and other objects. The following were collected:

Spongilla lacustris (Linn.), *Spongilla fragilis* Leidy, and *Myenia fluviatilis astrosperma* Potts.

These three forms appeared to be closely associated.

Near the surface of one of the beach ponds, the water was a bright green due to an abundance of ciliated protozoans (*Stentor igneus* Ehr.). Another conspicuous protozoan in one of the marsh lakes produced large, jelly-like colonies It appeared to be *Ophrydium* sp., which the writer has found abundant in Walnut Lake, Oakland County, Michigan (Hankinson, 1908).

Vertebrates Other Than Fish.

The amphibians and reptiles of the Whitefish Point region have been studied and a paper published on them (Thompson and Thompson, 1913). A number of species were taken in the course of the field work on fish, which were, *Rana pipiens* Shr., *Rana septentrionalis* Baird, *Rana clamitans* Latreille, *Bufo americanus* LeConte, *Thamnophis sirtalis* (Linn.), and *Chrysemys belli* Gray. Tadpoles were found in some numbers in quiet sunny shoals of Shelldrake River and Shelldrake Lake and in shallow, quiet tributaries of Vermilion Creek.

Many birds were present in the region during the time of the field work, but like other terrestrial animals, they were given little attention. A detailed report on the birds and mammals of the region has been published by N. A. Wood (Annual Report of the Michigan Academy of Science, Vol. XVI, pages 55-73). Since these forms have been treated by Mr. Wood, only notes on the beaver, *Castor canadensis michiga-*

nensis (Bailey) will be given in this paper, for this species is related to the fish life of the marsh lakes in an especially important ecological way.

The work of beavers was very manifest almost everywhere about the marsh pools. These were in the form of lodges (Ruthven, 1914), submerged piles of sticks gathered for food, felled trees, dams (Plate XVB), and networks of channels through the marshes. The dam on Mason's Creek was a new one, and above it a large pond had been recently formed; this had many dead trees standing in the water, as well as dying ones with wilting leaves. Forest conditions are rapidly changing to pond conditions here; and thus a new dwelling place for fish will in all probability be formed. The marsh lakes appear to be very good habitats for beavers. Both the marsh and lake region are readily accessible one from the other by the animals, and by means of channels they can easily get to wooded areas where there is an abundance of food in the way of young trees.

Climatic Features.

The climate of the Whitefish Point region is probably that of northern Michigan generally with a little more than the usual rainfall due to its proximity to Lake Superior. According to data given by Leverett (1911), the mean annual temperature of the Northern Peninsula is near 40° F, with a few days when it exceeds 90° F, and a few when it is below 20° F. In August, the average temperature is near 60° F. The rainfall is near 34 inches each year; at Whitefish Point it varied from less than 25 inches to near 30 inches from 1906 to 1910, inclusive. There is considerable snow, and winter conditions last usually from early November to late April. The small lakes are frozen over during this time. The warm season is, therefore, short, with spring, summer, and autumn conditions from May to October. There is an abundance of sunshine, and the periods of daylight are from 3 A. M. to 9 P. M., a length of time favorable for plant growth.

In August, 1913, when most of the fish work was done, the weather was, for the most part, pleasant with days mostly warm and sunny and nights cool and clear. There was a rainy day or two and a few showers of short duration. The season was called by residents a wet one. From July 15, 1913, to August 28, 1913, the range of temperature readings at the Life Saving Station on Lake Superior beach were from 38° F. to 89° F. With the permission of the U. S. Life Saving Service, these readings are published here:

	Midnight.	6 A. M.	Noon.	6 P. M.	Wind.
July 15	47	46	55	54	W-N. E.
16	52	63	72	63	S-SE.
17	60	56	60	52	SE.-N-W.
18	52	56	55	56	N. W. S-W.
19	57	55	61	58	W. S. W.
20	52	53	54	56	N-N. W.
21	50	54	63	70	N. E. S.
22	64	62	76	67	S. S. W. E.
23	60	61	56	55	S-N-W.
24	48	52	54	52	W.
25	50	54	65	65	N. S. W. N. E.
26	61	62	73	71	S-S. E.
27	68	70	75	70	S. N. E. W.
28	54	56	58	60	N-W.
29	48	52	64	60	S-N-W.
30	55	60	80	72	W-S. E.
31	77	76	68	61	S-N-W.
Aug. 1	60	62	62	60	W.
2	55	63	60	60	S-W-N.
3	63	53	59	58	N-W.
4	52	52	62	60	N-W-E.
5	60	58	62	60	S-N. E. S.
6	61	57	62	60	N-N. W.
7	59	60	75	70	N. E.-SE.
8	64	64	75	64	S. SE. W-E.
9	62	64	67	66	S-N. S. W.
10	59	58	56	52	W-N. NW.
11	54	54	67	63	SE. SE.
12	60	58	71	70	SE. NE. N.
13	58	62	76	73	S. E. N. E. E.
14	65	66	82	80	S. E.
15	68	68	89	82	SE.-S.
16	77	67	74	72	S. N. NW-N.
17	67	64	66	62	W-S-W.
18	62	64	68	66	NW. E. N.
19	65	62	73	70	E-SE.
20	56	60	77	70	SE.
21	64	63	66	62	S. E. SW. E.
22	62	54	60	57	W. SW. NW.
23	52	53	59	58	N. NE. N. W. NE.
24	55	49	48	46	N. W-N-NW.
25	38	40	71	62	
26	59	60	63	60	
27	55	56	55	60	
28	58	60	68	60	

The wind as shown in the above table varied much as to direction in the late summer of 1913. It also varied in intensity, but only a few times was it strong enough to produce a very rough sea on the lake. Water temperatures were taken with each fish collection. A list is here given with accompanying air temperatures taken at the same times. The latter are given in parentheses.

Lake Superior Shoal; water under two feet deep: 65 (60), 65 (70), 66 (67), 55 (68), 66, 64.

Beach Ponds: 65 (79), 80 (82), 70 (63), 69.

Marsh Lakes: 71 (69), 73 (68), 73 (77), 76 (72), 73, 72 (72), 70 (70), 62 (60), 69 (60), 68 (58), 75 (62), 64 (60), 70 (68), 75 (70), 74 (68), 75 (64), 67, 69 (60) 65 (64).

Outlet Streams of the Marsh Lakes: 68 (62), 69, 74 (68), 65.

Shelldrake Lake 68 (59), 65 (68).

Shelldrake River: 63 (70).

Methods and Acknowledgments.

In the study of the fish of the Whitefish Point region, extensive collections were made and each was studied in detail before another was taken up. An attempt was made to get a complete collection of the fish inhabiting the region, but not to such an extent as to interfere with the study of the habits of the species in their respective habitats. A convenient laboratory was fitted up, and the fish were studied in an aquarium. In this way it was possible to become well enough acquainted with the different species so that they could easily be recognized under favorable circumstances in the water afield.

For watching fish binocular field glasses and a water-glass were found very helpful. In Lake Superior a large, fifty-foot minnow seine and smaller "common sense" seines were hauled on the marginal shoal. Fish from the deeper shoal were obtained from fishermen, who very willingly permitted the writer to examine their "catches," and to retain desirable specimens. In the marsh lakes and beach ponds a six-foot, "common sense" seine was used almost everywhere. This can readily be handled by one person while wading or from a row boat. In the marsh, in narrow beaver channels, and for scooping under banks of streams, under gale growths, and about sedge clumps, a large minnow dip net (1 1-2 x 3 ft.), was successfully used. A minnow trap on the plan of a fyke-net was kept set much of the time, and some interesting specimens were taken with it.

Many photographs of the fish and their environments were taken to supplement the field notes, negatives and prints of which are filed in the Museum of Zoology, Ann Arbor, Michigan. The field work was nearly all done by the writer unassisted, but at times help and suggestions were given by the following named residents of Vermilion: John Clarke, Will Clarke, Fred Wetherhog, and Captain J. A. Carpenter of the Life-Saving Station. Special mention should be made of the services given by Mr. John Clarke, whose lamented death in May, 1914, removed a good friend, advisor, and efficient assistant to the members of the several field parties. Mr. Robert Carlson, lightkeeper at Whitefish Point, furnished information concerning the fisheries at that place. Mrs. Hankinson prepared and identified plants and contributed in other ways to the progress of the work. Mr. Seymour Bower, Superintendent of the Michigan Fish Commission, made the investigations possible by procuring a permit to collect specimens of fish. The work was done under the direction of A. G. Ruthven, Director of the Museum of Zoology and Chief Naturalist of the Michigan Geological and Biological Survey. Mr. N. A. Wood of the Museum of Zoology at Ann Arbor gave the writer some useful suggestions and directions and col-

lected some fish for him in the region. The following specialists named material collected:

E. N. Transeau, Charleston, Illinois, Algae and some seed plants,
Philip Dowell, Port Richmond, New York, Club-mosses,
C. K. Dodge, Port Huron, Michigan, Seed Plants,
G. N. Calkins, New York, New York, Protozoans,
N. A. Harvey, Ypsilanti, Michigan, Sponges,
J. P. Moore, Philadelphia, Pa., Leeches,
Bryant Walker, Detroit, Michigan, Mollusks,
J. G. Needham, Ithaca, New York, Dragon-flies,
J. R. De la Torre Bueno, White Plains, New York, Hemiptera,
C. Betten, Lake Forest, Illinois, Caddice-flies,
Chas. A. Hart, Urbana, Illinois, Water beetles,
V. E. Shelford, Urbana, Illinois, Tiger beetles,
O. A. Johannsen, Ithaca, New York, Aquatic Diptera,
Chancey Juday, Madison, Wisconsin, Entomostracans,
Miss Ada Weckel, Oak Park, Illinois, Amphipods,
Miss Harriet Richardson, Washington, D. C., Isopods,
A. E. Ortmann, Pittsburg, Pennsylvania, Crayfish,
A. G. Ruthven, Ann Arbor, Michigan, Amphibians and Reptiles.

FISH HABITATS.

Fish are the most abundantly represented of all the vertebrates of the Whitefish Point region, but they do not inhabit all of the bodies of water or all parts of any one of them. Descriptions of the more important places where fish are found will be given for the purpose of enabling one to understand better the conditions under which the different species live in the region. Data on the relations of the fish to the environmental factors in their habitats will be included, although little information of this kind was revealed in the necessarily brief time that could be spent in the field. The portions of the bodies of water examined are called stations and are designated by numbers; those near Vermilion are indicated on the sketch map (Fig. 3). They may be classified as follows:

Lake Superior Shoal
- Deeper Shoal
- Marginal Shoal

Beach Ponds
- Lower Beach Ponds
- Upper Beach Ponds
  - Open Pond
  - Marsh
  - Beaver Dam Pool

Marsh Lakes
Deeper water Areas
Shallow water Areas
Marsh bordered Shoal
Wooded Shore
Outlet streams
Shelldrake Lake
Shelldrake River

Lake Superior Shoal.

Deeper Shoal. Station 2. At the end of Clark's pier, at Vermilion, the water is about six feet deep. The zone having this or a little greater depth out to about ten feet is called the deeper shoal, and the part of it examined, about the end of the pier, is Station 2. Plate XIIB shows the region in the background. The following conditions maintained at Station 2 during August, 1913: depth, 6-10 feet; water clear, cold, and commonly disturbed, even to the bottom; bottom of clear, yellow sand; and visible plants absent. The species of fish, found in the order of their apparent abundance, were: lake herring, common sucker, brook trout, long-nosed sucker, Menominee whitefish, common whitefish, rainbow trout, and tullibee.

The fish caught were all fair-sized examples of their species, since they were caught by fishermen for the table. Direct observations are easily made of all parts of this station from the pier end. At times, many fish were seen which could not be positively identified, but it is evident that the station is visited by these larger fish periodically, and they do not permanently inhabit the place. Small fish also frequent this region, but according to the writer's observations, only on their way to or from shallower or deeper water. Immense numbers of little fish were seen about sunset after an unusually warm and quiet day moving in a steady, direct, purposive way from the shallower water near shore close to the water surface and going out to some depth beyond. None were seen lingering at this station.

Marginal Shoal. The zone of shallow water close to the shore, out as far as collections could be obtained by wading, is called the marginal shoal. The conditions here are as follows: depth three feet or less; water usually clear, only clouded by sand or debris close to shore when breakers are present; water cold; bottom of hard, clear, yellowish sand or with pebbles, the latter forming a discontinuous, marginal zone; no visible plants except some *Ulothrix zonata* on submerged parts of piles and other objects; aquatic animals other than fish inconspicuous. Gnats and caddice-flies (*Mystacides sepulchralis*) were seen at times over the water surface; a kingfisher, at one time, was

seen to dash in where small fish were schooling near the shore. In four places, there are unusual conditions, near the mouths of the three streams draining the marsh and where there is a broad sand flat free of pebbles and debris, a short distance west of Vermilion (Station 5). Here a person can wade out several hundred feet before reaching water waist deep. The mouths of streams appeared to have no special attraction for shoal fish except that of Vermilion Creek, which is probably due to kitchen wastes thrown in it a short distance up stream from its mouth The shoal here is called Station 1. Many small fish were observed at times about the entering water. The following species were collected at this station: *nine-spined stickleback, lake herring, common sucker, common perch, common sculpin, common whitefish, brook trout, spot-tail minnow, long-nosed dace, and brook stickleback.

The little herring were in large, compact schools, and the whitefish were associated with them. The common suckers and the nine-spined sticklebacks were both numerous, and each species schooled by itself with a few individuals of one often in large schools of the other. The perch associated little with other species but were solitary or in little companies. The sculpins lived on the bottom among the pebbles, and there were probably many more of them at Station 1 than the collections revealed since it was difficult to catch them with a seine. Small burbots were apparently for the same reason poorly represented in collections. The brook sticklebacks and spot-tailed minnows and long-nosed dace were all very scarce.

Over the large submerged sand flat, Station 5, thousands of young herring and nine-spined sticklebacks schooled. A few young whitefish, suckers, and perch were also here; the first closely associated with young herring and the other two were chiefly by themselves.

Pebble-covered shoals appeared to be avoided by all the shoal fish except the bottom forms—sculpins and burbots. Often immense schools of sticklebacks were seen just off the pebble zone and not moving over it.

The main food of these little shoal fish appears to be entomostracans, chironomid larvae, and adults of various insects that fall into the water, and filamentous algae (*Ulothrix zonata*).

Beach Ponds.

Upon the Lake Superior shore, there are a number of small bodies of water, some only temporary, and formed in depressions (Plate XIII) by the waves during storms and some larger and formed by the damming of the small streams. The latter are the only ones of interest here

*In the lists of fish given in this habitat discussion, the species are named, as far as possible, in the order of apparent abundance, the best represented one first.

for they alone contained fish. The beach ponds belonging to creek systems are of two kinds: (1) those of the lower beach, which are close to Lake Superior and freely connected with it and (2) those of the older, upper, or fossil beach several hundred feet back from the lake and with scarcely any water connection with the lake except during spring floods.

Lower Beach Ponds. Two of these were found in the region near Vermilion, one at the mouth of Cranberry Creek (Station 31, Plate XVA) and one a mile or so farther east on Wetherhog Creek (Station 121). Fish might readily enter these ponds from Lake Superior, but there is no evidence that they often do this. No fish were found on the lake shoals anywhere near the mouths of these two streams, and the fauna of these ponds is very different from that of Lake Superior. Each of these ponds is long and narrow, extending several hundred feet making a small angle with the lake margin. The water is stained brown but free from sediment and has a variable temperature, usually about that of the air. They are shallow, under two feet in depth and the bottom is of hard, yellow sand with conspicuous "ripple marks." No vegetation except some diatom scum and filamentous green algae was evident in the water and the shore was practically barren of vegetation. There were no noticeable water invertebrates, except a few insects. Some aquatic beetles (*Coptotomus interrogatus*) were caught. The following fish, given as near as possible in the order of their abundance, were found in these pools: common sucker, red-bellied dace, *Leuciscus neogaeus*, Cayuga minnow, silvery minnow, common perch, horned dace, brook stickleback, Iowa darter, and brook trout.

All of the fish taken in these pools are small examples of their species, and none were represented in any numbers except the suckers, which were only in a depression about two feet deep around a partly submerged stump at Station 31. Here were a great many little suckers with very small examples of the other species listed, except the trout. Only one trout was found and this was beneath a water-logged piece of wreckage. Very few fish were moving out in the open water of the pond, but all stayed about objects which afforded some concealment.

Upper Beach Ponds. The ponds of the upper beach are about two miles west of Vermilion and are much larger than those just considered and possess a larger biota. They are fed by Mason's Creek, and a little, shallow, narrow outlet winds over the beach to Lake Superior. The series of several ponds are not distinct from each other but are expansions of one system. Two of these are much larger than the others and are about five hundred by seventy-five feet. Much vegetation is in and about these bodies of water, and this approaches in character that of the marsh lakes farther back from Lake Superior. At the

upper end of the series plants are especially numerous and form a small marsh (Station 172, Plate XVIB). A short distance above this a beaver dam is across the creek near where it emerges from the woods (Plate XVB). The dam is a new one and has caused the creek to flood a large wooded area recently. Below the dam is a pool (Station 171, Plate XVB).

Much invertebrate life was in evidence about these pools and marshes. The following aquatic forms were taken in the net with fish collections: dragon-fly larvae (*Aeschna*, *Somatochlora*, *Gomphus*), water striders (*Gerris remiges*), and leeches (*Macrobdella decora*, *Haemopsis marmoratus*, and *Placobdella rugosa*). Attached to many submerged objects were sponges (*Spongilla fragilis*). A protozoan (*Stentor igneus*) swarmed near the water surface, giving a considerable area of it a bright green color.

The noticeable vertebrates were frogs, tadpoles and a number of birds. In general four types of fish habitats are present: (1) the deeper, open water areas; with water about three feet deep and a hard sand bottom, over which there is little debris or humus; water plants are absent, except a few small patches of stoneworts or bladderworts, (2) the marsh region, with a thick growth of partly submerged sedges, rushes, flags, sweet gale, and a number of others and also much green algae on the surface and much stonewort beneath it, (3) marginal areas of very shallow water, two or three inches deep, and unusually warm, and well exposed to sunlight owing to a scarcity of seed plants, and (4) the pool beneath the beaver dam (Station 171, Plate XVB), which is about twenty by thirty feet with a depth of about three feet down to the sand bottom, over which there is a foot or more of dead leaves, sticks, and other litter, and growths of stonewort; the water was cold (65° F.) and stagnant, since the pool is supplied by percolations through the beaver dam.

In the open deep areas (No. 1, above), the following fish were taken: black-head minnow, Cayuga minnow, horned dace, *Leuciscus neogaeus*, black-nosed dace, and brook stickleback.

None of these were abundant or generally distributed in this type of region. The Cayuga minnows were chiefly in a few large schools in the deepest water; and those observed were large examples of their species, while all the other fish taken were much undersized.

In the marsh area (No. 2, above), chiefly in the more open places, the following fish were caught: red-bellied dace, silvery minnow, black-head minnow, horned dace, *Leuciscus neogaeus*, Cayuga minnow, black-nosed dace, mud minnow, and brook stickleback.

Most of these fish were small, under an inch in length, and each species, except Cayuga minnows, *L. neogaeus*, and mud minnows, was

abundantly represented. This marsh is the only place in the Whitefish Point region where horned dace were found in any numbers. The marsh appears to be an important feeding ground for the smaller fish.

The marginal shoals (No. 3, above) were visited by many small fish, but a representative collection of them was not made; one species, the barred killifish, seemed to be confined to these places and was tolerably common.

The pool below the beaver dam (No. 4, above) was frequented by brook sticklebacks, red-bellied dace, *Leuciscus neogaeus*, black-nosed dace, and mud minnows.

The sticklebacks were numerous, and appeared to thrive better than in any habitat examined in the Whitefish Point region. Some of them were large, being nearly three inches long. A few opened had been eating insects and algae. The other fish were all small and present only in small numbers.

Marsh Lakes and Streams.

The small lakes among the sand ridges on the strip of lowland along Lake Superior with their outlet streams, channels, pools, beaver runs, and other bodies of water connected with them, contain many small fish and some large ones. They are, moreover, everything considered, the most productive places for studying and collecting aquatic organisms in the Whitefish Point region. The lakes given particular attention are close to Vermilion and are shown on the sketch map. The names used for these were for the most part invented by the writer.

According to Leverett (1911), regions below the Nipissing shore line, including the lowland about Vermilion, are very young geologically, perhaps not older than three thousand years. When the waters of the Great Lakes descended to their present level, sand ridges, produced probably by both waves and ice, were formed with the intervening depressions. Marsh plants began to grow and thrive here till they captured the shallower parts of the flooded low ground. In places, the beavers made dams to retain and elevate the water, which on rising drowned out portions of the marsh or otherwise changed its features. These animals thus helped to preserve the small lakes, and in this and other ways they have been a dynamic factor in determining the character of the fish habitats. Man has also affected the region in a similar way by damming the water to facilitate cranberry culture. No inlets were found leading to these lakes, except short streamlets from springs near the base of the Nipissing bluff. They appear to be fed chiefly by seepage from the higher ground. The bottom of these lakes is at foundation a hard, yellow sand, but over this in many places, there is

a thick stratum of loose, buoyant muck, barren of visible growing vegetation. Where this deposit is absent, the clean yellow sand supports few plants; but where a little humus is present, there is often a growth of submerged aquatic plants, principally stoneworts, pondweeds, bladderworts, water weeds, and water lilies. The marshy shores have, as a rule, either sedge growths (Plate XXIIB) or partly submerged patches of sweet gale (XXIA). Cat-tails, bulrushes, smartweeds, and some other plants characterize the open marsh region. In a number of places, the wooded swamps extend to the lake margin (Plate XXIIA). The water of these marsh lakes is without evident turbidity, but is slightly brown stained. In temperature it was found commonly to be about that of the air, and the readings made were not far from 70° F.

Although fish are numerous in these lakes they are not found in all of them or in all parts of any one of them. They have a marked tendency to dwell near the shore, although bottom and water conditions in midlake are very similar to those about the margin, except for those produced by the shore features. Muck bottoms are evidently much preferred to the sandy ones. On account of these restrictions in distribution, very definite fish habitats could be found. A consideration of the important types of these will now be made. It is very difficult and apparently impossible to work out these habitats in a successional way, on account of complications in their history, brought about by dams, channels, and other structures built by beavers and man and by the removal of beaver dams by man, when their presence interfered with cranberry culture and other interests, but in general the habitats have developed as follows. When the water receded from the Nipissing to the Lake Superior level and the sand ridges were formed, the intervening depressions were capable of containing water in sufficient amounts in some cases to form small lakes. Wind and water borne sand and accumulating humus tended to make these lakes shallower. Beavers, however, converted parts of their shoals into deep water areas by digging channels. Similar work may have been done by water currents. Marshes followed the shoals by the encroachment of plants on them, but in places there is a reversion to lake conditions by the formation of channels and pools in marshes by beavers and sometimes this occurs temporarily when the marshes are flooded by man to protect or harvest cranberries. These operations appear to be the chief source of the muck deposits over the sand bottom in these lakes. A considerable amount of this light black soil could be transferred by beavers from the marshes while making their channels or while using them as runways, and when the lakes are lowered by opening the sluices in dams for flooding cranberry marshes, currents might be set

up in these channels that would wash much of this material into the lake. A rapid accumulation of muck over a plant association would obliterate it, and the looseness of the soil would prevent plants again taking root. Thus regions like Stations 52 and 55 could be produced. In more open parts of the lakes, this light muck may be carried and very generally distributed by wind-made water currents. Beaver Lake and Spruce Lake have muck practically over their entire bottoms. It is possible that currents sweep this away completely in some cases, thus returning the shoals to a primitive type, that is, with sandy bottoms and no plants, but a continued accumulation of organic debris in these lakes must in time bring about a firm substratum, peaty in nature, that will support plants readily. The marsh, then, can rapidly encroach on the lake, and the last stage as a fish environment would thus be reached. Beaver channels and pools will finally give way to the marsh if man destroys these animals, as he is rapidly doing at present. Spruce swamps encroach on the open marsh and, in places, they have reached the edges of the lake producing conditions for fish life which are different from those of other parts of the lake (Plate XXIIA).

The probable developmental relation of these fish habitats to each other is shown in the diagram below.

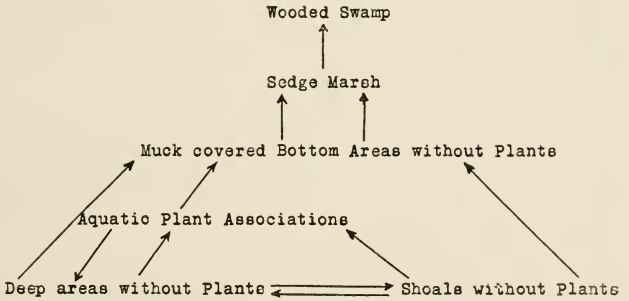


Diagram showing probable developmental relation of fish habitats near Vermilion, Michigan.

A classification of the fish habitats in the marsh lakes may be made as follows:

Deep Water Areas; five to seven feet. Natural depressions, deep channels, beaver excavations, etc.
With few or no visible plants
With stonewort association
With pondweed association
With water-lily association

Shallow Water Areas; about three feet and under
- Without higher plants (barren shoal)
- With stonewort association
- With water-weed (*Elodea*) association
- With pondweed association
- With dense growth of submerged aquatic plants, a number of kinds forming a complex association
- With thick deposit of muck over a sandy bed; no higher plants
- With sweet gale (*Myrica*) association
- With water-lily (*Nymphaea*) association

Marsh Area, sedge, gale association
- With shallow water about plant bases
- With beaver channels and pools

Wooded Shore.
Outlet Streams.

Examples of the above-listed types of fish habitats in the marsh lakes, so far as they were examined, are here described in detail.

Deep Water Areas without Vegetation. This type of fish habitat is poorly represented in the small lakes, for most of the water is less than four feet deep. Where it is considerably more than this, from about five to seven feet, it is called deep water. The channel of Vermilion Lake (Station 25, Plate XXIIIB) is in many places of this depth with the bottom of hard sand. No collections were made in the channel, but from the boat only a few large perch were seen. Apparently there were no minnows or other small fish. It is likely that these are poor feeding places and used by fish chiefly as highways. Fish lingering here would be much exposed to the attacks of pikes, which undoubtedly frequent regions of this type; some huge ones were seen in this channel and other deep parts of the marsh lakes. A large sculpin was caught in a place of this character by N. A. Wood.

Deep Water Areas with much Vegetation. Some deeper parts of the channel of Vermilion Lake (Plate XXIIIA) had many water lilies forming patches. Scarcely any fish, except a few very small ones, about an inch in length, and a few large perch were seen about these. At the east end of this channel, Station 24, there is a region where the water is five or six feet deep and where much fine-leaved pondweed grows. The area is roughly circular and about a hundred feet in diameter with gale and sedge-formed shores and an island of gale near its center. A nearly submerged pile of beaver-cut wood lies against this. The bottom is of hard, yellow sand. This depression was undoubtedly dug out by beavers. Large perch frequented this place; and they were easily caught with a hook baited with leeches. On one occasion a huge pike,

two or more feet long, was seen to move away from here on the approach of the boat. Some small fish were seen here, but they were uncommon.

Shoal Areas without evident Plants. These have a hard, sandy bottom with very few or no rooted aquatic plants. A strip of region of this type examined lay along the dam at the west end of Vermilion Lake (Station 28). Fish were uncommon here as at other places of the type and with many hauls of the seine only a few examples of *Leuciscus neogaeus*, brook sticklebacks, and Iowa darters were caught. There is an extensive shoal of this type at the north end of Little Lake but almost no fish were found over it. At Station 111, of Hay Meadow Lake, barren shoal is also prevalent with the usual scarcity of fish.

Shoals with Stonewort Association. Shallow water a few inches deep with thick bottom mats of stonewort plants is found in a number of bays near the east end of Vermilion Lake. One of these (Station 53) was given particular attention. This extends some three hundred feet into the marsh and is from about twenty to eighty feet wide. Only very small fish, an inch or so long, including many little brook sticklebacks, were found over this growth. Others caught were red-bellied dace, *Leuciscus neogaeus*, black-head minnow, and Iowa darter. Crayfish dwelt in the stonewort masses. In the westward prolongation of Spruce Lake (Station 84) stoneworts covered a very thick muck deposit almost everywhere. Large mats of these plants often became detached and came to the surface and floated as shown in (Plate XXIB.) Only a few very small fish were found here as elsewhere where stoneworts covered the bottom.

Shoals with Water Weed Association. Water weeds (*Elodea canadensis*) grow in dense patches on a hard sandy bottom in Hay Meadow Lake (Station 111), where the depth is about two feet. Many Iowa darters were found among these plants, but no other fish were found with them.

Shoals with many Aquatic Plants forming a dense, complex Association. In a few, shallow, sheltered places, submerged plants are numerous, filling the water. One of these is at the west end of a small lake (Station 101) where pondweeds, stoneworts, bladderworts, green algae, with partly submerged rushes, sedges, sweet gale, and other plants form a complex association that nearly fills the water leaving little swimming space for water animals (Plate XXIIIB). The entire lake is characterized by an abundance of vegetation (Plate XXIIIA). At Station 101 mud minnows are common, and this is a typical habitat of the species. A great many small *Leuciscus neogaeus* were caught along the margin in different parts of the lake. These were about an inch in length. A few small Iowa darters were also caught in this lake. A small pike was noted. The following aquatic invertebrates were

common about the water plants: Sponges (*Spongilla* sp.), leeches (*Placobdella rugosa* and *Haemopsis marmoratus*), snails (*Physa heterostropha*), and insects (*Libellula pulchella*, *Somatachlora* sp., *Leucorhinia intacta*, *Aeschna* sp., *Arctocorisa nitida*, and *Dytiscus* sp.).

Muck Bottom Shoals without Plants. The shoals, with deposits of loose muck forming layers from a few inches to five or more feet thick over hard, sandy substrata were along much of the shore region of these small lakes, but the layer is thickest in wind sheltered places such as small bays. A good example of one of these is Station 55, which is a bay running into the marsh on the northeast shore of Beaver Lake. Here the muck is two or three feet thick with two feet or less of water over it. The sand foundation is not down so far but that wading and hence collecting can be easily done; and the muck is scarcely more resistant than the water to a person going through it. The bay is irregular in form and some seventy-five by a hundred feet in diameter. It opens into the lake by a mouth about fifty feet wide. The sedges of the marsh about it are nearly three feet high and form marginal clumps (Plate XIX). The water is slightly brown stained but free from sediment and was found usually to have a temperature of 70° F. This station has the largest and most constant fish population for its size of any station studied in the Whitefish Point region, and it is evident from general observations about the marsh lakes that the conditions in this bay are those most attractive to the fish of these small lakes. The following species were found here: red-bellied dace, Cayuga minnow, black-head minnow, silvery minnow, *Leuciscus neogaeus*, Iowa darter, brook stickleback, common perch, horned dace, white sucker, mud minnow, and common pike.

The first five species listed associate closely with each other, forming dense, compact schools that tend to gather in peripheral depressions, getting as near the marsh as possible but apparently not entering it. They were probably finding food especia'ly abundant near it. Dissections showed that diatoms, alga filaments, and insects were being eaten. Sticklebacks were abundant and very generally distributed in this bay; they were not in company with other fish or noticeably with each other. They rest, apparently motionless, off the bottom, and when the muck is disturbed they quickly gather about the cloud so made, evidently looking for food.

Only one mud minnow was caught and this in the minnow trap placed on the bottom near the middle and deepest part of the bay. This species may be abundant in this bay, but because of the habit of hiding in the mud (Gill, 1904), few could be captured with nets. The Iowa darters could be seen "creeping" over the surface of the muck

bottom, leaving little trails behind them. A few pikes were noted in and about this bay.

A few dragon fly larvae (*Somatochlora* sp.) and many small Sphaeriums (*Sphaerium rhomboideum*) and a few snails (*Physa heterostropha*, and *Planorbis antrosus striatus*) were the aquatic invertebrates found at this station in making fish collections. Some tadpoles and a turtle were noted. A solitary sandpiper was flushed, and a kingfisher remained about the station, and now and then its splash could be heard as it struck the water, or it could be seen to dash from a dead tamarack to the place where fish were schooling. Recently used channels and other evidences made it appear that beavers were frequenting this bay at the time the field work was being done. These animals certainly constitute a dynamic feature in the aquatic life of this bay.

Another bay (Station 52) with similar conditions to that of Station 55 is a short distance east of Station 55 and connected with the bay called Station 53 (Plate XXA). It is oval in surface form and some fifty by eighty feet in diameter. A deposit of muck some six or seven feet thick exists here. In all probability the bay was dug out by beavers. Hundreds of fish were seen here on every visit. They were similar in relative numbers and manner of association to those of Station 55. The following were collected: red-bellied minnow, Cayuga minnow, black-head minnow, silvery minnow, *Leuciscus neogaeus*, Iowa darter, brook stickleback, and common sucker.

Shrub-bordered Shoal. In a number of places small shrubs (*Myrica Gale*) form fringes about the edges of these lakes. Fish find seclusion near and among the submerged bases of these plants. Station 59 (Plate XXB) and Station 71 (Plate XXIIA) are the examples of this type studied. Pikes were frequently seen here, apparently in ambush. Red-bellied dace, Cayuga minnows, black-head minnows, and brook sticklebacks were also often found and schools of large common suckers stayed about the gale fringe of Station 59. Many of the suckers were a foot or a little more in length, and dozens of them were seen at every visit to the place, although none were noted elsewhere in the marsh lakes except for a few at Station 55. This may have been due to the unusually deep water, about three feet, along this shore.

Sponges were abundant on submerged gale branches. Those collected were *Spongilla lacustris*. Amphipods (*Hyalella knickerbockeri*), dragon-fly larvae (*Tetragoneura* sp.) and dipterous larvae (*Chironomus* sp. and *Ceratopogon* sp.) were also noted.

Water Lily Association in Shallow Water. A place of this kind is Station 116 (Plate XXIVA). A large school of small perch, about an inch and a half long, and also many little minnows, an inch or less in length, were found in this habitat.

Marsh Areas. The water in the sedge marsh close to the lake is frequented by mud minnows and a good many small examples of other species common in the lakes. The latter was composed of black-head minnows, brook sticklebacks, Iowa darters, *Leuciscus neogaeus*, and silvery minnows. These were mostly about an inch in length and were caught chiefly in the marsh near Station 55 and at Station 115. When the marshes are artificially flooded, the small fish of the lakes are said to go over them in large numbers. The marshes are undoubtedly used as breeding grounds for pike in the spring, and people living at Vermilion tell of their coming into these places at that time.

Some water insects and other invertebrates were taken in the marsh. Mosquitoes were very numerous. A few specimens belonging to the species, *Anopheles quadrimaculatus*, were caught. About the bases of the sedge plants some dragon fly larvae (*Plathemis lydia* and *Somatachlora*) were taken, also a few snails (*Planorbis antrosus striatus* and *Physa heterostropha*).

Beaver Channels and Pools in the Marsh. These are narrow passages through the marsh dug by beavers. Some of them are quite deep and extensive as at Station 51. These lead to houses, a number of which are on the island in the east part of Beaver Lake. The passages are from about two to seven feet in width and three or four feet deep, and have a great deal of the soft muck on their bottoms. Five radiating from the house and one connecting the channel system with the lake are present at this station. Many small fish frequented them, but no collections of them were made. To what extent beavers are a factor in forming little bays like Station 52 and 55, is an interesting problem. It can readily be seen how a group of radial channels like those of Station 51 could start one of these bays by being widened till the marsh between them is obliterated.

Wooded Lake Border. Stations 85 and 110 are of this type. Trees here produce much shade, which is the chief characteristic of this type of habitat. Much submerged brush is present, which furnishes hiding places for small fish. On the shore with trees are many shrubs, logs, fallen limbs, and much herbage, including sedge growths. The lake margin is cut up by little bays or channels that are numerous on the swamp floor. The following species were caught along wooded shores: black-head minnow, red-bellied dace, *Leuciscus neogaeus*, Cayuga minnow, brook stickleback, and common pike.

Pikes find many retreats in the shore indentations. Black-head minnows were numerous at Station 85, and hundreds of them crowded up into the little bays and channels. Brook sticklebacks also frequented these places in some numbers. Attached to the submerged

brush were many sponges (*Myenia fluviatilis astrosperma*) as well as dragon-fly larvae, leeches, snails and other invertebrates.

The marsh lakes have three small outlet streams in the Vermilion region, called by the writer, Vermilion Creek, Cranberry Creek, and Wetherhog Creek (Fig. 3).

Vermilion Creek flows from a pool at the junction of three channels (Station 24, Fig. 3), the largest of which extends southward to Beaver Lake. It is, for the most part, an artificially dredged ditch with a board dam, which has a controllable spillway so the water may be made to rise in the several ditches of the cranberry marshes to flood them. According to many observations the creek above the dam has a fish fauna like that of the marsh lakes. Below the dam, the stream is irregular in width and depth, perhaps six or seven feet on the average and shallow except for a few "holes" where the water is still and nearly two feet deep with mud bottom and growths of pondweeds, filamentous algae, and other aquatic plants. These are favorite places for brook sticklebacks. Where the creek cuts under the bank small brook trout find hiding places from which they are easily captured with a dip net. Fish were seldom seen out in the open stream, but stayed in deep places. Their absence here may have been due to blue herons which feed along this creek (Plate XXIVB). The following fish were taken in this part of the stream (Station 22): brook stickleback, brook trout, silvery minnow, common sucker, and *Leuciscus neogaeus*.

A number of other animals were taken in the few net collections made at Station 22. Among these were: two kinds of leeches (*Eropdella punctata* and *Haemopsis marmoratus*), crayfish (*Cambarus virilis*), dragon-fly larvae (*Somatochlora* sp., *Gomphus* sp., and *Aeschna* sp.), water bugs (*Lithocerus* sp.), water beetles, and snails (*Physa heterostropha*). Tadpoles were abundant in shallow tributaries of this creek and a number of frogs were seen about it.

At Vermilion the creek is covered with a tramway made of heavy timbers and driven piles. It extends out into Lake Superior about a hundred and fifty feet as a strong pier (Plate XIIB, background). The separated overhead cross timbers of this structure put the creek in heavy shade like a woodland stream. No leafy plants develop from its sandy bottom or shore. It is a few feet wide, rather swift, and but a few inches deep, except in a few restricted areas where it is two feet or so deep. The following fish were caught under this tramway (Station 21): brook trout, common sucker, long-nosed sucker, red-bellied dace, common perch, burbot, and common sculpin.

The trout here are small, but one nearly a foot long was seen. They were all found beneath submerged objects in the deeper parts of the creek. Schools of little suckers wandered into the creek short dis-

tances from the Lake Superior shoal. Twelve large examples of long-nosed dace, a little over three inches in length, were caught in a depression of the creek bottom, where the water is about two feet deep, just above the stream mouth. This very small and restricted region is the only place in the whole area studied, where any but very small long-nosed dace were taken. These large ones from Station 21 were eating black-fly larvae, which made up all of the material in the intestines of four of the dace opened. The other species from this station, listed above, were scarce. The burbot was caught in the small fyke net set across the creek just above its mouth so as to catch entering fish. It is possible that burbots visit the creek at night for food.

Cranberry Creek is a short stream which cuts through the sand ridge along the Lake Superior beach a short distance east of Vermilion (Plate XIVB). On the beach it spreads out into a long, shallow pond (Station 31, Plate XVA). The part of the creek through the sand ridge (Station 30) was the only part examined. Here it runs some two hundred feet below a small road bridge, winding about making pools and narrows; the former are as deep as three feet and as wide as fifteen feet, while at the narrows the creek is constricted to two or three feet and is but a few inches deep. The water is clear but slightly stained brown; it is swift, and moderate in temperature (68° F. at times when the principal collections were made). The bottom is of clean dune sand except in pools where much organic debris has collected. The banks are high, with scant vegetation, and are well-lighted. The following species of fish were taken in Cranberry Creek: brook trout, black-nosed dace, *Leuciscus neogaeus*, horned dace, common sucker, and brook stickleback.

The small, deep pools with overhanging banks harbored a number of small brook trout, but this was the only species well represented; only a few of each of the others listed being found.

Wetherhog Creek is a short stream running from below a dam at the end of Wetherhog Lake and expanding in a beach pond. The creek is wide and very shallow and concealed by bushes for much of its course. Fish were scarce in it, and few little perch and some Iowa darters were the only ones taken in many hauls.

Shelldrake Lake.

The lake that lies in the course of the Shelldrake River some two miles southeast of Vermilion (map Fig. 3 and Plate XXVA) is in general similar to the larger of the marsh lakes just described. It is perhaps a little over a half mile in length by a quarter of a mile in width. An extensive shoal is present and apparently a large deep water

area, but this could not be examined. The bottom of the shoal is of hard sand with a thin layer of humus over it in many places and much vegetation occurs in this shallow water, although irregularly distributed. Partly submerged bulrushes, yellow water lilies, scouring rushes (*Equisetum*) form large and conspicuous patches; and along the marshy shore at the west end are rank growths of *Sagittaria*, cat-tails, and sweet gale, as well as sedges, grasses, and other plants. Under the water are pond-weeds, bladderworts, tape grass, and water milfoil. Sponges produce conspicuous tufts and incrustation on submerged brush and other objects; some collected were *Myenia fluviatilis* and *Spongilla fragilis*. Leeches were common, and two forms were taken, *Haemopsis marmoratus* and *Placobdella rugosa*. Some isopods (*Mancasellus tenax*) were found. Larvae of May-flies (*Heptagenia*), some water bugs (*Corixa*), and a few whirl-i-gig beetles (*Gyrinus canadensis*), were the aquatic insects taken.

The more detailed observations on the fish were made at Station 142 (Plate XXVB). Small perch were very abundant here but they stayed about the water lily zone. Good-sized Cayuga minnows were in large schools on the shoal but chiefly on parts where the water lilies were absent and thus not associated closely with the perch. A few small pikes were found in the sweet gale zone along the shore here. One good-sized one (about nineteen inches long) was captured beneath the gale. The species of fish taken at this station were as follows: common perch, Cayuga minnow, spot-tailed minnow, common sucker, common pike, black-sided darter, Johnny darter, and common sculpin.

In the large marsh area at the west end of the lake and cut through by Shelldrake River, one or two specimens of each of the following were caught: mud minnow, common pike, Johnny darter, and common sculpin. A small crayfish, *Cambarus propinquus*, was taken here with the fish.

Shelldrake River.

A portion of Shelldrake River, about a half mile in length, lying about two miles southeast of Vermilion and about a quarter of a mile above Shelldrake Lake, was examined by wading the entire length of this portion and dipping with the hand seine in all places likely to have fish.

This part of the stream winds through a swamp with alders, spruces, birches, pines, and other trees, which produce a very dense growth (Plate XXVIA). It averages here perhaps thirty feet in width, but in places narrows to a few feet and widens to as much as fifty feet. The water is clear, and very free of sediment but stained. The bottom is of hard, firm sand and is bare almost everywhere except that it is

covered with humus in depressions or about plant growths. The depth is mostly less than two feet, but very irregular, with many shoals and pools, some five or more feet deep. Wading could be done, however, almost everywhere. The water was cold (63° F. on the day when the examinations of this part of the stream were made), and almost everywhere with a good current, but there are no rapids. Water plants were abundant in the swifter parts of the stream, forming oblong patches; the principal ones of these were tape grass, stoneworts, or slender-leaved pondweeds, and *Vaucheria*, the latter forming bottom mats or tufts.

Sponges (*Myenia fluviatilis*) were found, and crayfish (*Cambarus propinquus* and *C. virilis*) were caught. Water insects were usually in evidence. On the surface, were many water-striders and whirl-i-gig beetles (*Gyrinus ventralis* and *G. canadensis*). Beneath the surface, black-fly larvae were abundant on the leaves of tape grass, and some dragon-fly and May-fly larvae and caddice-worms were caught. Small bugs (*Arctocorisa nitida*) were taken in quantities in the seine. A few snails (*Physa gyrina*) were collected.

Small tadpoles were seen on quiet marginal shoals. Frogs and small toads (*Bufo americanus*) were frequently seen along the shore of the stream. Kingfishers were absent, which may have been due to the scarcity of small fish. Some beaver work was noted, but these mammals probably influenced the meager fish fauna of the river to a very slight degree. All conditions appeared to be favorable for a large fish fauna, but nevertheless fish were surprisingly few both as species and individuals. This part of the river looked like a fine trout stream but no trout were found in it by the writer or anyone else, according to good testimony. Brook trout are in the south fork of Shelldrake River, according to information received; and they have been planted there but apparently not elsewhere in the river. The following species of fish were caught in Shelldrake River: common sculpin, long-nosed dace, common pike, common sucker, Cayuga minnow, common perch, and long-eared sunfish (?).

The first three species are apparently the only ones at all generally distributed in the part of the stream examined, and sculpins are much more common than the others. A number of long-nosed dace were caught, but they were all very small. These, with the sculpins, were taken in the masses of stoneworts, tape grass and pondweeds that grow in the swift parts of the stream. The presence of so many sculpins may be an important factor in keeping trout from the stream for they are well-known destroyers of trout eggs. One sculpin opened had been eating a large burrowing May-fly larva and some other insects. Small pike were frequently seen along the quiet margins. A sculpin two

inches long was taken from a pike ten inches long. Another, smaller pike had eaten some small fish that were too badly digested for identification, and still another had fed upon insects. The suckers were scarce. All seen were little fish in a small school. The sunfish (two taken in a small bay with a muddy bottom) were the only members of the sunfish family found by the writer in the Whitefish Point region. A little perch, the only one caught in the river, was caught in the net with these sunfish. Conditions in Shelldrake River, thus, appear to be favorable for but one kind of fish, the common sculpin. The other species were not thriving there and were represented by few or small individuals.

LIST OF SPECIES.

The list below contains the data on thirty species of fish represented in the collections made in the Whitefish Point region by the writer. Following this is a hypothetical list giving names of species whose presence was not ascertained by the writer's data, but from published notes on their distribution and from statements made by people living in the region, the fish listed probably in some cases, possibly in others, belong to the fauna of northern Chippewa County. When there was opportunity to do so, color descriptions were made of fish fresh from the water or from aquarium specimens. Ridgway's Color Standard and Nomenclature (1912) was used in this work. Dimensions of fish are stated in inches and tenths of inches. The lengths given are total ones, from the tip of the snout to the tip of the caudal fin.

1. *Coregonus clupeaformis* (Mitchill). Labrador Whitefish.—Whitefish are abundant in Lake Superior, but they are chiefly in a zone where the depth is between sixty and a hundred feet (Paul Reighard 1910). This zone is close to the shore at the east end of the region, at Whitefish Point, but westward it departs farther and farther from the shore and is about eight miles out at Vermilion. The proximity of the area to the shore at Whitefish Point makes it very available to fishermen; hence the importance of the fishery there. Moore (1895) states that the best whitefish grounds on Lake Superior are at Whitefish Point. Goode (1884) calls attention to the importance of the fishing grounds here and to the many whitefish caught and the large size of some of them; he states that in seventy-four barrels of whitefish taken at one time, none were under six pounds and records one specimen that weighed twenty-three pounds. Mr. Robert Carlson informs the writer that about thirty tons of whitefish are taken at the Point every year, and the largest one that he knows of taken there weighed twenty-six pounds.

It is known that Labrador whitefish migrate shoreward, apparently to feed on insects, in the summer (Nash.1908 and Patton 1912), and

apparently the catching of a few adults, each nearly a foot long, in about eight feet of water at Vermilion in August 1913, is evidence of such a movement. One of these fish had in its stomach insects of several kinds, some of which were winged. In summer insects undoubtedly fall in the water in large numbers along the shore.

The specimens collected from the deeper part of the shoal (Station 2) agree well with the description of *Coregonus clupeaformis*, given by Jordan and Evermann (1911), but there is a possibility that some or all of them were Lake Erie Whitefish, *Coregonus albus*, many of which have been planted in Lake Superior. Mr. H. H. Marks says that fish packers can distinguish the two forms, and Mr. Carlson reports two types in the region, those with dark backs and those with backs more yellowish in color. From all this information it appears likely that *C. albus* is a valid species and is found in the Whitefish Point region.

Eighteen little whitefish, 3 to 3.5 inches in length, were found in a lot of small herring of similar size to them on the shoal of Lake Superior, at Stations 1 and 5 (Plate XXVIIIB). These were undoubtedly either *albus* or *clupeaformis* (Hankinson 1914) and perhaps both were represented in the schools. A typical one of these is described as follows: length, 3.5 inches; head in body, 4; depth in body, 5; eye in head, 3.5; snout in head, 3.5; interorbital space in head, 3.5; ventral line of caudal peduncle, 2.3; least depth of caudal peduncle in head, 3; dorsal rays, 12; anal rays, 12; branchiostegals, 8; gill-rakers, 10 plus 16; scales in lateral line, 75.

The writer has been unable to find a record in the literature of whitefish beyond the fry stage as small as these taken at Vermilion. Kendall (1903), writing of *Coregonus clupeaformis*, says, "It is not known to the writer that the young of this species has been observed, except the fry at fish hatcheries, or where they are to be found after leaving their birthplace in the thoroughfares and streams, or at what age they leave these places. It is probable that when quite young, they go to deep water, where, having thus escaped their enemies in the streams, they become the prey of rapacious fishes of the lakes." G. B. Goode (1884) says, "Relative to the movements of the whitefish in Lake Superior, Mr. George Barnston is of the opinion that the young and immature whitefish confine their range entirely to shallow water near shore. He states that pound nets in twenty to forty feet of water catch great numbers seven to eight inches long. From the fact that none have been found in lake trout stomachs, he infers the young whitefish are not in deep water where the trout dwell."

Eight of the little whitefish were opened and their food examined. The principal data are given below:

Size of fish, inches.	Entomostracans.	Chironomid larvae.	Winged insects.	Miscellaneous insects.	Algae.
*2.4	*Bosmina, Cyclops*	Several	One		
2	Copepods			Chironomid pupae	*Ulothrix zonata*
2.5	Copepods and Cladocera				*Ulothrix zonata*
1.9	Copepods				
3.5	Copepods and Cladocera	Few		Insect legs	*Ulothrix zonata*
3	Copepods	Few		Few	*Ulothrix zonata*
2.4		One		One	
*3	*Bosmina, Diaptomus and Cyclops*		Several	Insect pupae	*Ulothrix zonata*

*Stomach contents examined and identified by Chaney Juday.

The young whitefish, as shown above, were eating entomostracans freely, and this appears to be the chief food of those found near Vermilion. Chironomids were also taken by them in important numbers. In general the food of the young whitefish appears to be like that of the adult (S. I. Smith, 1873a, Forbes 1883a, Hankinson 1908, and Patton 1912). No evidence was obtained that whitefish spawn in the Vermilion region; a sandy bottom like the one there is unfavorable for this activity according to most writers. Leathers (1911), however, tells of their spawning on the broad sand flats in Huron County, Michigan. Mr. Robert Carlson informs the writer that whitefish spawn near Whitefish Point.

2. *Coregonus quadrilateralis* (Richardson). Menominee Whitefish.—This species was found common on the deeper part of the shoal near Vermilion (Station 2). Those taken were of edible size, a little over a foot long. Two typical specimens opened had been eating principally amphipods; one had these only in its stomach, and the other had miscellaneous insect remains in addition to them.

3. *Leucichthys harengus* (Richardson). Saginaw Bay Herring.—The many herrings found in the deeper part of the Lake Superior shoal are probably of this species for they agree with the description given of *L. harengus* by Jordan and Evermann (1911), who state that "The ordinary herring of Lake Superior are placed provisionally under *Leucichthys harengus*, of which they constitute a tangible variety or subspecies, distinguished by the larger size, the more cylindrical form, and, in general, by the still smaller adipose fin. But these characters are average only, and are subject to much variation, hence we refrain from regarding the Lake Superior herring a distinct species."

Large schools of little herring, two to three inches long, were frequently seen close to the shore, at Stations 1 and 5, but preferring the latter where there is a broad sandy area. Here they formed compact schools, which had remarkable coordination and rapidity of movements, making it difficult to get them with a seine. Associated with them

were a few young whitefish and other species. These young herrings were, in all probability, the same species as the adults taken from the deeper shoal, but since there are at least four other *Leucichthys* in Lake Superior (*L. supernas, L. cyanopterus, L. zenithicus,* and *L. tullibee*), whose young are apparently unknown in this body of water, it is possible that they also have young representatives on the shoal.

The coloration of one of the large herrings from Station 2, just as it was taken from the water, was as follows: upper parts, yellowish olive, except for a porcelain green streak just back of the dorsal fin; lower parts white, with light pinkish lilac reflections on the sides; dorsal and caudal fins olive; lower fins white. The very small herrings caught close to shore were similar in color to the large ones, but they were paler and more silvery on the sides.

Many lake herrings are caught at the Whitefish Point fishery. Mr. Carlson reports sixty tons taken there in 1914. They constituted the chief food fish for residents of Vermilion during the time the writer was in the region, and they are of much importance to these people. Many of them were discarded as unfit for food on account of parasitic worms in them. These were of two types: nematodes in coiled masses in the coelome and cestodes embedded in the flesh of the back.

Four small ones were examined as to their food, which was found to consist entirely of entomostracans, chiefly *Cyclops viridis brevispinosus.*

Forbes (1888) and Juday (1907) give notes on the food of Lake Herrings. G. B. Goode (1884) considers them great destroyers of whitefish eggs.

4. *Leucichthys tullibee* (Richardson)? Tullibee.—A tullibee was taken by a fisherman at Station 2, in a gill net (Plate XXVIII). In depth of body, size of eye, and number of branchiostegals, it is more like *L. manitoulinis* than *L. tullibee,* but it is most like the latter in length of head, maxillary, and anal fin and in the number of gill-rakers and scales before the dorsal fin. It, therefore, seems best to assign it to the species *tullibee,* but not with positiveness, because these characters are apparently variable (see table page 33, Jordan and Evermann 1911), because either species may be found in Lake Superior, and because the writer is able to examine but one specimen of tullibee and is unable at present to compare this with type specimens.

The following descriptive notes were made on this fish: Length, 10.6 inches; length to base of caudal fin, 8.5 inches; depth in length (to base of caudal) 3.3; adipose fin in eye, 1.3; eye in head 4.4; caudal peduncle, 2.5 in head; head in length, 4.3; dorsal fin with 12 developed rays; anal with 12 rays; scales in lateral line, 74; branchiostegals, 8;

gill rakers, 16 + 32; color (fresh from water of the lake) upper parts bluish gray; lower parts white with brassy reflections on the sides.

5. *Salmo irideus* Gibbons. Rainbow Trout.—One specimen was taken at Station 2. It was about a foot in length, and in color was bluish slate above and white below, sides silvery with pinkish reflections, many small black spots scattered over the back and sides as well as the dorsal and caudal fins, which had a ground color like that of the back; lower fins white.

Four small fish, each about three inches in length, distended the stomach of this trout. They were badly digested, but there can be little doubt but that they are little herring.

The species is not native to Lake Superior, but it has been introduced in waters connected with it. Fishermen say that they are frequently taken in Lake Superior in the Whitefish Point region. Townsend (1902) records the capture of three at Whitefish Point, and of a large one, weighing seven pounds, taken there on July 9, 1900.

6. *Salvelinus fontinalis* (Mitchill). Eastern Brook Trout.—Common in a number of places in the Whitefish Point region, in Lake Superior, in the lower part of Vermilion Creek, in lower Cranberry Creek; and one was found in the beach pond into which Wetherhog Creek flows. None were seen in the marsh lakes or in Shelldrake River or Lake. In Lake Superior, the fish are of edible size, usually about a foot long. Here many were seen and some were caught in about six feet of water about Clarke's pier (Station 2). The following notes were made on a typical specimen from here just after it was taken from the water: length, 10.5 inches; color very pale compared with stream fish; a light bluish-green above, with faint marblings of a slightly darker shade of this color; sides silvery gray with lilac reflections and with a few indistinct spots, some white and some red; dorsal and caudal fins yellowish-green with dark mottlings; the other fins and the lower parts of the fish white.

All of the fish caught elsewhere than in Lake Superior were small; the dozen or so examples taken were 3 to 8.5 inches in length. The largest one of these was of a light yellowish-green above and white below; the sides had broad, slaty, transverse bands or "parr marks," which are found on small brook trout, and had conspicuous bright red spots.

In the small streams the brook trout were never seen unless disturbed, and then they would dart from beneath banks or other hiding places and back to near the same place; never swimming any distance in the creek before finding a retreat. A small trout found under a water-logged piece of timber in the beach pond at Station 122, re-

mained under this even when it was dragged on the bottom or rolled over; and it moved out far enough to be caught in the seine only after many attempts were made to dislodge it.

The food of brook trout in the region is, in all probability, chiefly insects, as it is in the other places where the food of the species has been examined (Needham and Macgillivray 1903 and Juday 1907). One fish from a stream had remains of insects in its alimentary canal, including winged forms, and one from Lake Superior had eaten a fly and a small fish.

The brook trout is a well-known game fish in eastern North America and a species that attracts many fishermen to northern Michigan, thus benefitting the state (Dickerson 1904 and Newcombe 1904); but no evidence could be found that the Whitefish Point region is ever visited by trout fishermen. In fact, the species appears to be of little value to the few people living there. None large enough for food are in the streams, and the ones in Lake Superior are only to be caught in small numbers and then with difficulty.

7. *Catostomus catostomus* (Forster). Long-nosed Sucker.—These suckers were frequently taken with common suckers from Station 2, but they were not as common as the latter. Three typical specimens (10.5-16 inches long) were preserved. In color they were as follows: dark greenish-olive finely spotted with light greenish-yellow due to each scale having a center of that color; sides yellow with metallic reflections; below white with a pinkish tinge, dorsal and caudal find similar to the back in color; lower fins of a light reddish brown.

The only other place where this species was found was in the beach pond at Station 31, where three little ones were caught.

8. *Catostomus commersonii* (Lacépède). Common Sucker.—Abundant in the shallow water of Lake Superior, both close to the shore, where schools of many little ones were frequently found, and farther out in eight or more feet of water, where many individuals about $1\frac{1}{2}$ feet long were taken. Schools of the little suckers entered Vermilion Creek to feed near its mouth and also the beach ponds freely connectes with the lake (Stations 31 and 121). None were found in Mason's Creek or the connecting ponds on the Lake Superior beach. They were only locally abundant in the marsh lakes, since they were only found along the north shore of Beaver Lake, chiefly at Station 59 (Plate XXB). Some were present in Shelldrake River and in Shelldrake Lake, but they appeared uncommon here.

All of the little fish from close to the Lake Superior shore, chiefly in one or two feet of water, as well as those from the beach ponds were very uniform in size and appearance, commonly about 2.5 inches long. One of the larger fish (16.5 inches long) from the deeper shoal (Station

2) was in color like the others taken there. It was of a dark greenish-olive above with numerous lighter spots of the same color due to each scale having a center of a lighter shade. The lower parts were white, and the sides had brassy, metallic reflections.

The suckers in Beaver Lake are quite large. Many of them were about a foot in length, and they moved in large schools in two or three feet of water along the gale zone on the north side (Station 59). The three specimens caught there measured seven to eight inches in length. There was much food in their intestines composed of chironomid larvae, filamentous algae, diatoms, and undeterminable material. Eight specimens of the little common suckers from Lake Superior shoal had been eating chironomid larvae, entomostracans, *Ulothrix* filaments, diatoms, and winged insects, with chironomids the principal food in each. Tracy (1910) says that these suckers eat young fish and fish eggs. Kendall and Goldborough (1908) found them feeding on black-fly larvae.

Common suckers are probably an important source of food for lake trout in Lake Superior (Nash 1913). In Beaver Lake, large pikes were especially common at Station 59 where these suckers predominated. Residents of Vermilion used them little if at all for the table although many were taken with nets. The fish were given to chickens.

9. *Chrosomus erythrogaster* Rafinesque. Red-bellied Dace.—Red-bellied dace were found to be the most abundant of all the species of fish in the marsh lakes south and west of Vermilion, but in those east of Vermilion (Hay-Meadow, Mitten, and Wetherhog Lakes) the species is at least scarce for no examples could be found in the several large collections made in them and their outlet streams. Likewise, none were taken from Lake Superior, Shelldrake River, or Shelldrake Lake. A number were found in the few collections made at the north end of Little Lake. These dace preferred the shore regions of the small lakes in which they were found, especially the small deep bays and beaver channels, and the neighborhood of submerged patches of sweet gale.

The several hundred specimens captured ranged in length from .7 to 3 inches. The coloration of a few typical large ones was as follows: olive green above; white below, with two indistinct dark stripes along each side of the back above the two prominent lateral ones separated by an area of yellowish green. These linear markings furnish a character by which the species is readily identified in the water. In some of the largest dace, the white lower parts were more or less red, a feature found in breeding males.

The red-bellied dace were most often found in schools, commonly associated with other species, but usually predominating when present. Station 55 (a marsh bay of Beaver Lake) was an ideal place for them.

The immense schools of minnows here contained more red-bellied dace than other species, but the following were also abundant in the schools: *Leuciscus neogaeus*, Cayuga minnow, black-head minnow, and silvery minnow.

The intestines of a number of the dace examined were filled with humus and many diatoms, alga filaments, and some pine pollen. Data on the food of the species is given by Forbes (1883), Needham (1908) and Ellis (1914).

10. *Hybognathus nuchalis* Agassiz. Silvery Minnow.—This species was found to be abundant at Station 55, in schools with red-bellied dace and other species (see supra). A few were found in other parts of the marsh lakes, except those east of Vermilion, where there were none. They are also found in the beach ponds west of Vermilion. Nowhere were they of full size, except at Station 55 where conditions appeared unusually favorable for the species. One which was opened had been eating some insects including chironomid larvae and mud rich in diatoms.

The hundred or so captured measured from 1 to 3.3 inches in length. One of the larger ones was colored as follows: light-yellowish olive above, below white with yellowish reflections, a distinct black lateral band, sides not silvery as they usually are in this species.

11. *Pimephales promelas* Rafinesque. Blackhead Minnow.—The species is similar in distribution to the red-bellied dace and the silvery minnow in that it is abundant in the west group of marsh lakes near Vermilion and relatively scarce and of small size in the east group. Like the others, it also finds optimum conditions in marsh bays (Station 52, 53, and 55). It was common in the beach ponds at Mason's Creek, and some were found in Little Lake.

Over two hundred of these minnows were taken; they measured from .7 to 2.5 inches in length. One of the larger specimens was of a light-yellowish olive above, fading to the white of the lower parts, and had a black, lateral stripe.

Mud rich in diatoms was found in a few intestines examined. Forbes (1883) found the species eating mud and insects, and Fowler (1908) states that it eats green algae and mud.

12. *Semotilus atromaculatus* (Mitchill). Horned Dace.—Horned dace were uncommon in the Whitefish Point region. Small specimens .7 to 2.7 inches long were caught in Beaver Lake, in Cranberry Creek and in the beach ponds west of Vermilion. The last named place was the only one in which they were found to be at all common.

13. *Leuciscus neogæus* (Cope). This abundant species of minnow also belongs to the red-bellied dace association, and is very similar to it in distribution, except that it is fairly common in the east marsh

lakes. All of the specimens in the east lakes were small, however. Many occurred in the beach ponds of the Mason's Creek region, and some were found in a small shallow bay at the north end of Little Lake.

A hundred or more specimens were taken, which were 1 to 3.4 inches long. In color a typical large one was light yellowish-olive above and yellowish-white below, with a whitish streak along each side of the body, and below this a grayish line, and then a jet black stripe. The sides in a few specimens were tinged with pink, which brightened anteriorly. This species resembles the red-bellied dace but differs from it in having a more robust form, a larger and more oblique mouth, and a single, not double, black lateral stripe.

14. *Abramis chrysoleucas* (Mitchill). Golden Shiner.—Small golden shiners (1 to 1.3 inches long) were found in Mitten and in Wetherhog Lake, but none were taken elsewhere.

15. *Notropis cayuga* Meek. Cayuga Minnow.—Cayuga minnows were common and very generally distributed in the Whitefish Point region. They were common in the upper beach ponds west of Vermilion, in the west group of marsh lakes, and in Shelldrake Lake. A few were caught in Shelldrake River, and many were taken in the east marsh lakes, but these were small in size, not over 1.5 inches long, while most of the individuals caught in the west group (Beaver Lake and others) were about 2.5 inches long. The largest numbers were found at Station 55, where they belonged to the red-bellied dace association. There is a tendency in most regions, however, for Cayuga minnows to school by themselves.

Two large examples caught at Station 55 had been eating entomostracans, insects, and diatoms.

16. *Notropis hudsonius* (DeWitt Clinton). Spot-tailed Minnow.—The minnow appears uncommon in the region, except possibly in Shelldrake Lake. Six were obtained from Lake Superior close to shore in two feet or less of water; they were small, an inch or less in length, except one, which was a fine large specimen 3.5 inches long. This large specimen answers more closely to the description of typical *N. hudsonius* than it does to *N. hudsonius selene*, which is considered to be the typical Lake Superior form. The other fish were too small for subspecies determination. The only other place where spot-tailed minnows were found in the region was Shelldrake Lake, where many little ones, less than an inch long were found in the collections made along its northwest shore (Station 142. Plate XXVB).

17. *Rhinichthys cataractae* (Cuvier and Valenciennes). Long-nosed Dace.—This fish was found in one very restricted region,—a deep area under the pier in Vermilion Creek, and close to Lake Superior. Twelve large ones (3 inches long on the average) were caught here (Plate

XXVIIB). In but two other places were long-nosed dace taken,—in Shelldrake River and on the Lake Superior shoal at Station 1, and these were small (about 1.5 inches). It was quite common in the river, and was found among thick plant growths in swift water.

One of the large fish from Vermilion Creek was grayish olive-green above and on the sides, under parts pinkish white, an indistinct dark, lateral band, the fins and head with a pinkish tinge.

18. *Rhinichthys atronasus lunatus* (Cope). Black-nosed Dace.—This species is also much restricted in the region and not at all associated with the long-nosed dace. It is abundant in the beach ponds formed by Mason's Creek, but was found elsewhere only in Cranberry Creek, where it appeared scarce. The eighty or more caught were from 1.5 and 3 inches in length.

19. *Umbra limi* (Kirtland). Mud Minnow.—Mud minnows are common in the shallow water of the marshes about the marsh lakes, and they are also found in some numbers in these lakes, but little information could be obtained concerning their abundance and distribution on account of the difficulty of getting them from the dense vegetation and the deep mud of their habitats in which they are said to retreat on being approached (Gill, 1904). Station 101 (Plate XXIII B) is a typical habitat for this species in the Whitefish Point region. A single specimen was found in the stomach of a pike taken in Wetherhog Lake. The twenty-two specimens collected measured 1 to 3.3 inches in length.

20. *Esox lucius* Linnæus. Common Pike.—Fish of this species are common in the marsh lakes and in Shelldrake Lake and River. None were found elsewhere in the region, but in all probability it occurs in Lake Superior (Townsend 1902).

Individuals reach a large size in the marsh lakes, at least in the west group, just south and west of Vermilion, where some very large ones were seen. A specimen 30 inches long caught on a trolling hook in this habitat weighed $6\frac{1}{2}$ pounds. In color it was black on the back, sides gray, with scattered spots of greenish-yellow, lower parts yellowish-white. A pike 19 inches long was taken in Shelldrake Lake by the writer.

These large pikes preferred the deeper water of the marsh lakes and the cover of vegetation, such as gale growths. A number were usually seen at Station 59, perhaps to prey on the suckers that schooled there. Small ones (four to ten inches) were common in shallow bays of these lakes and of Shelldrake River.

The stomachs of the small pike caught were for the most part empty. One had eaten a mud minnow and a leech; in another, from Shelldrake River, a sculpin was found.

The pike is a well-known predator. Notes on its food are given by Forbes '78, '88, and '88a, Kirsch '94, Marshall and Gilbert '05, and Reighard '13a. Besides fish they sometimes eat crayfish, other crustaceans, water insects, and leeches.

Residents of the Vermilion region seldom use the pike for food; its flesh is said to be "wormy." The large specimen caught in the marsh lakes had flesh of the usual good quality for the species, and no parasites were evident in it. Pikes are said to be detrimental in the region by catching wild ducklings and young muskrats.

The marshes about the small lakes must furnish excellent breeding places for pikes in the early spring, and according to information given by residents many frequent these places at that time.

21. *Fundulus diaphanus menona* (Jordan and Copeland). Barred Killifish.—Seven (1-3 inches) were caught from two diverse and separated regions; five from the Mason's Creek pools and two from the west end of Mitten Lake. The species is poorly represented in the region.

22. *Eucalia inconstans* (Kirtland). Brook Stickleback.—The brook stickleback is very common and generally distributed in the Whitefish Point region. It was found in all of the bodies of water examined, except Shelldrake River and Lake. Only two, very small ones were taken in Lake Superior. They were numerous in the beach ponds connected with Mason's Creek, and the pool beneath the beaver dam here appeared to have optimum conditions. Many were also observed in Vermilion Creek, where they prefer deep, quiet pools with much algae and other vegetation. While they are numerous in Beaver Lake and others of the west group, they are scarce in the east group, the beaver dam at Station 110 apparently marking the limit of their eastward extention in this system of small lakes. They are very common in Little Lake, at least at its north end.

The sticklebacks were easily seen and distinguished in the water, and they were usually suspended, apparently motionless, off the bottom. When the bottom soil is disturbed they quickly gather about the cloud, evidently looking for food. They appear to be insectivorous in the region for insects with a little algae made up the stomach contents of the few opened.

The two hundred or more specimens collected were from .7 to 2.7 inches in length.

23. *Pygosteus pungitus* (Linnæus). Nine-spined Stickleback.—This species was not found elsewhere than in Lake Superior, where it is exceedingly abundant, outnumbering by far all other kinds of fish found there. The enormous schools came shoreward in quiet, warm weather, where they remained a short distance out from shore in about

a foot of water. They were not closely associated with the other small fish, but a few small suckers and young herring were occasionally with them. For some reason, they avoided all but the sandy bottoms and in no instance were these schools seen over the pebble zone, although often close to its margin.

The sixteen specimens opened had been eating entomostracans. The material appeared to be the same in all of the fish, and it was of an orange color and showed through the thin body walls of most of the several hundred captured. The contents of twelve stomachs were sent to Mr. Chancey Juday, who determined the material as fragments of *Cyclops viridis, brevispinosus, Diaptomus ashlandi,* and *Bosmina longirostris.* It will be seen that these hoards of little sticklebacks were eating the same objects as were the young whitefish and herrings. They are, thus, of some economic interest as competitors of these more useful fish.

24. *Lepomis megalotis* (Rafinesque) (?).—Two small sunfish were taken in a little bay having about a foot of water and a mud bottom in Shelldrake River. These were the only sunfish, in fact the only members of the Centrarchidae found by the writer in the Whitefish Point region.

They were each about 1.5 inches long. While they answer well to the descriptions of *L. megalotis* and resemble specimens of that species, the present state of our knowledge of *Lepomis,* makes it impossible to identify with certainty such small specimens as these, especially since they came from a region remote from any where sunfish have heretofore been thoroughly studied.

25. *Perca flavescens* (Mitchill). Yellow Perch.—Perch were common and the most generally distributed of all the fish in the Whitefish Point region, according to the writer's notes. Many small ones (1 to 1.5 inches long) were present on the shoal of Lake Superior, either solitary, in schools, by themselves or in schools of small suckers and herring. They did not appear to associate with the sticklebacks. They are uncommon in the beach ponds, and none were found in those not freely connected with Lake Superior. The marsh lakes contained many perch, both large and small, and here also they were found as solitary individuals and in schools, the latter being always made up of perch of about the same size. Companies of large perch appeared to wander freely about in some of the marsh lakes, not clinging to the neighborhood of the shores as most of the smaller lake fish did. They tended, however, to remain in the deeper water, from which they were readily caught with hooks baited with leeches.

In the northwest corner of Shelldrake Lake conditions seemed to be

very favorable for young perch for large numbers of them were found about the water lily growth there.

Some of the large perch from Station 24 of the marsh lakes were colored as follows: light yellowish olive above with transverse bands of olivaceous black, sides yellowish-white, under parts white, pectoral and anal fins greenish yellow, ventral fins reddish orange.

One fish, 8 inches long, from Station 24, had eaten two leeches and a caddice larva. In the stomachs of four little perch from the Lake Superior shoal were entomostracans (*Cyclops viridis brevispinosus* and *Diaptomus ashlandi*), which were the same as those making up the bulk of the material in the stomachs of the young whitefish, herring, and sticklebacks found in the same habitat. Notes on the food of this species are given by S. I. Smith (1873a), who found them eating small fish, spawn of fish, and dipterous larvae, and by Forbes (1880), who obtained from stomachs of adults, mollusks, crustaceans, insects, and small fish, and in the stomachs of the young entomostracans and *Chironomus*. Forbes (1890a) records perch eating large, red *Chironomus* larvae in certain Wisconsin lakes. Marshall and Gilbert (1905) state that perch eat insect larvae, snails, crayfish, some other crustaceans, minnows, fish spawn, plankton, and plants.

Perch are eaten by at least two species of fish found in the Whitefish Point region, the common pike and the burbot (Reighard 1913 and Forbes 1888).

G. B. Goode (1884) considers perch common along the south Lake Superior shore and states that Whitefish Bay has fishing grounds for perch, and that fishermen consider them detrimental to whitefish.

26. *Hadropterus aspro* (Cope and Jordan). Black-sided Darter.—One small example of the black-sided darter, an inch long, was found in the collection made in the shallow water at the northwest corner of Shelldrake Lake.

27. *Boleosoma nigrum* (Rafinesque). Johnny Darter.—Four specimens, 1 to 1.5 inches long, were found in the collection made at the northwest corner of Shelldrake Lake.

28. *Etheostoma iowae* Jordan and Meek. Iowa Darter.—This darter is common in the marsh lakes, but none were found elsewhere in the region, except one small example in the small beach pool at Station 121. In the marsh lakes they are present over both sandy and mucky bottoms. On the latter a network of their trails often formed a conspicuous bottom feature.

Some fifty specimens, 1 to 1.7 inches in length, were taken. A few of them were in high coloration as follows: above greenish-yellow with faint dark blotches, the dorsal fin black with a coral red band near its

outer edge, sides of the body with about ten feruginous spots interspersed with bluish dusky ones, below yellowish white.

29. *Cottus ictalops* (Rafinesque). Common Sculpin.—Sculpins are common on the Lake Superior shoal (Station 1), where they appear to frequent the pebble zone. Many were also found in Shelldrake River in the thick submerged masses of tape grass and stonewort, and a few were caught in Shelldrake Lake. They appeared to be scarce in the marsh lakes, as none were found in the many collections made from them by the writer. But in the summer of 1914, Mr. N. A. Wood caught two in the marsh lakes in three or four feet of water, one on a sandy bottom and the other over a mud bottom. Aquatic plants were absent in both places. No sculpins were found in the beach ponds or in the streams draining the marsh lakes except at their mouths. It should be stated, however, that this data on the distribution of sculpins in the Whitefish Point region probably has little significance owing to the difficulty of getting them with nets or of seeing them in the water.

Some thirty specimens were taken. These were 1 to 3.5 inches in length. One from Shelldrake River had a large, burrowing May-fly larva in its stomach as well as fragments of other insects. A sculpin was found in the stomach of a small pike taken in the Shelldrake River.

30. *Lota maculosa* (LeSueur). Burbot.—Two of these were taken, —one at Station 1 on the Lake Superior shoal and one in the mouth of Vermilion Creek. They were both small specimens, 2.5 to 7 inches in length. The largest one was colored as follows: above light greenish yellow mottled with darker, a violet reflection on the caudal fin, lower parts and lower fins white, the latter with a bluish and pinkish tinge.

The stomach of the larger specimen contained the remains of five or more small fish and chironomid larvae. The habits of the fish are similar to those of sculpins, hence few were noted. Residents of Vermilion say that they are common in Lake Superior. If so, their predaceous habits make them important enemies of fish in this body of water. Forbes (1888) found young perch, young whitefish, and a crayfish in the stomachs examined, and he considers young perch an important article of food for this species.

HYPOTHETICAL LIST OF SPECIES.

It is evident that only a month of collecting and observing would almost certainly not reveal all the species of fish found in the region studied. Lake Superior shoal forms could easily be overlooked and fish that visit this region at other times of the year would not be found. It was, therefore, considered advisable to attempt to make a list of species not found by the writer but probably present in the region, as a guide to future collectors.

On the preparation of this list the writer made many inquiries of members of the Life Saving crew at Vermilion and of others familiar with the aquatic life there, who were willing and capable of giving reliable information; and he has examined the literature pertaining to Lake Superior fish, and has corresponded with ichthyologists who might furnish facts concerning the aquatic biota of the region. Chiefly from these sources the data given in the following hypothetical list has been obtained.

1. *Acipenser rubicundus* Le Sueur. Lake Sturgeon.—Sturgeons are said to visit the shallow water of Lake Superior near Vermilion, and Mr. John Clarke informed the writer that they used to run up the Tahquamenon River which enters Whitefish Bay. Records of sturgeons in Lake Superior are given by Smith and Snell (1885), who say that they are captured there but seldom marketed. Cox (1897) states that they are often taken in Lake Superior. Townsend (1902) reports 711 pounds taken from Lake Superior in 1899 with pound and trap nets, and asserts that they are not as common in Lake Superior as in the other lakes.

2. *Amia calva* Linnaeus. Dogfish.—Mr. Robert Carlson reports that the dogfish or bowfin is caught at Whitefish Point.

3. *Leucichthys harengus arcturus* Jordan and Evermann.—This subspecies was recently described by Jordan and Evermann (1911). The type specimen is from Knife River, Duluth, Minnesota. It is possible that all *L. harengus* of Lake Superior belong to this subspecies.

4. *Leucichthys eriensis* (Jordan and Evermann).—Recorded from Port Arthur, Lake Superior, by Fowler (1911).

5. *Leucichthys supernas* Jordan and Evermann. Cisco of Lake Superior.—The species was described by Jordan and Evermann (1911). It is said to be a deep water form, living in water 300 feet or over in depth. Absence of information concerning the habits and characteristics of the young of this and other *Leucichthys* of Lake Superior, makes it impossible to determine whether or not this species is represented in the hosts of little herring that school in the shallow water of Lake Superior near Vermilion.

6. *Leucichthys prognathus* (H. M. Smith.) Cisco of Lake Ontario.—Nash (1908) reports this fish from the Great Lakes except Lake Erie, and it is recorded from Devil's Isle, Lake Superior, by the Bureau of Fisheries at Washington (Michael 1904).

7. *Leucichthys johannae* (Wagner).—Found in Lake Superior, according to Wagner (1910).

8. *Leucichthys nigripinnis* (Gill). Blackfin of Lake Michigan. The blackfin is said to be common in Whitefish Bay. Townsend (1902) states that 36,818 pounds have been taken in Whitefish Bay

since 1893, when it was first noticed there. Nash (1908) reports it as occasionally taken in Lake Superior.

9. *Leucichthys cyanoptera* Jordan and Evermann.—Found in deep water of Lake Superior (Jordan and Evermann 1911).

10. *Leucichthys zenithicus* (Jordan and Evermann).—This form according to Jordan and Evermann (1911) and H. M. Smith (1894), occurs in deep waters of Lake Superior.

11. *Leucichthys manitoulinus* Jordan and Evermann. Manitoulin Tullibee.—North channel of Lake Huron and perhaps in Lake Superior according to Jordan and Evermann (1911).

12. *Cristivomer namaycush* (Walbaum). Lake Trout.—No lake trout were found by the writer, but there is abundant evidence that they occur at least in the deep water near Vermilion. Mr. N. A. Wood got one weighing fifteen pounds about a mile out from Vermilion in the summer of 1914. John Clarke informed the writer that they frequent the shoal at times, and other reliable testimony as to their occurrence there was obtained. A number of plantings of the species have been made at Whitefish Point and Grand Marais.

The lake trout is a well-known predator. The one taken in 1914 by Mr. Wood had five sculpins, each about three inches long in its stomach. Nash (1913) states that they eat herrings, young whitefish, and other soft-finned fish. Mr. John Clarke says that they spawn in fall in five or six feet of water where the bottom is gravelly in Lake Superior. Nash (1908) states that the spawning season in Lake Superior commences early in October.

13. *Cristivomer namaycush siscowet* (Agassiz). Siscowet.—This subspecies is said to live in Lake Superior, in water from three hundred to nearly five hundred feet deep. Jordan and Evermann (1911) state that, "It is never seen in shallow water." It is doubtful if it should be included in this list.

14. *Salmo gairdneri* Richardson. Steelhead Trout.—These trout have been planted in streams tributary to Lake Superior and are said to frequent the open lake. Nash (1908) states that they have been introduced in Lake Superior with marked success.

15. *Hiodon tergisus* Le Sueur. Toothed Herring.—Probably occurs in Lake Superior. Nash (1908) states that it ranges to Lake Superior.

16. *Alosa sapidissima* (Wilson). The Shad.—Mr. Robert Carlson reports taking one at Whitefish Point. Nash (1908) says "it was formerly abundant in the lower Ottawa but has abandoned that river and its occurrence within our boundaries is now only accidental.

17. *Pimephales notatus* (Rafinesque). Blunt-nosed Minnow.—Recorded from Sault Ste. Marie by Meek and Clarke (1902). Found in

the Lake Superior Region at Bear Lake, Houghton County, Michigan, in 1905, by the writer.

18. *Notropis heterodon* (Cope). Black-chinned Minnow.—Recorded from Sault Ste. Marie by Meek and Clark (1902).

19. *Notropis atherinoides* Rafinesque. Shiner.—Recorded from the Lake Superior region by Agassiz (1850) and by Meek and Clark (1902).

20. *Notropis cornutus frontalis* (Agassiz).—Recorded from Lake Superior by Agassiz (1850) and from the Lizard Islands in Lake Superior and from Sault Ste. Marie by Meek and Clark (1902).

21. *Couesius plumbeus* (Agassiz).—Lake Chub.—In Lake Superior, according to Nash (1908). Recorded from the region by Agassiz (1850). Found in a small lake in Houghton County, Mich., in 1905, by the writer. Cope (1866) records it from Keweenaw Point. Jordan and Evermann (1896) give its range as including Lake Superior.

22. *Ictalurus punctatus* (Rafinesque). Channel Cat.—It is possible that this species is recorded from Lake Superior under the term "catfish" by Townsend (1902). A letter from the U. S. Bureau of Fisheries interprets this name as including this and the following two species.

23. *Ameiurus nebulosus* (LeSueur). Common Bullhead.—Recorded for Lake Superior by Agassiz (1850) and probably included under the term "catfish" by Townsend (1902), who states that 6,200 pounds of catfish and bullheads were taken in Lake Superior in 1899, by fyke, trap, and pound nets.

24. *Ameiurus lacustris* (Walbaum). Catfish of the Lakes.—Nash (1908) states that this species is distributed throughout the Great Lakes. Jordan and Evermann (1896) give it as abundant in the Great Lakes, and Townsend (1902) probably includes this species among the "catfish" from Lake Superior.

25. *Esox masquinongy* (Mitchill). Muskallunge.—Recorded from southwest Lake Superior by Goode (1884). Found in Portage Lake in Houghton County, Michigan, by the writer in 1905.

26. *Percopsis guttatus* Agassiz. Trout Perch.—Agassiz (1850) and Meek and Clark (1902) record the species from Sault Ste. Marie, Michigan. Nash (1908) states that it is frequently taken in the clear, cold water of Lake Superior.

27. *Ambloplytes rupestris* (Rafinesque). Rock Bass.—Townsend (1902) reports that 734 pounds of rock bass were caught in Lake Superior in 1899, with fyke nets, pound nets, and trap nets. Meek and Clark (1902) record it from Sault Ste. Marie.

28. *Micropterus salmoides* Lacépède. Large-mouthed Black Bass. —Found in Lake Superior, according to Michael (1904).

29. *Stizostedion vitreum* (Mitchill). Wall-eyed Pike.—Townsend

(1902) states that wall-eyed pike occur in Lake Superior and that they are caught chiefly in Chippewa County, Michigan. Goode (1884) says they are abundant in west Lake Superior, and gives a record of three hundred pounds taken at Whitefish Point, although they are not considered plentiful there. Apparently they are periodic in their occurrence in this region of the lake.

30. *Percina caprodes* (Rafinesque). Log Perch.—Found in Lake Superior according to Jordan and Evermann (1896), and recorded from Sault Ste. Marie by Meek and Clark (1902).

31. *Etheostoma caeruleum* Storer. Rainbow Darter.—Recorded from Lake Superior by Abbott (1860).

32. *Roccus chrysops* (Rafinesque). White Bass.—Nash (1908) reports the species from the Great Lakes of Ontario. Goode (1884) states that it is found about the Apostle Islands but not elsewhere in Lake Superior.

33. *Aplodinotus grunniens* Rafinesque. Fresh-water Drum.—Common and distributed throughout the entire Great Lake region, according to Nash (1908).

34. *Uranidea franklini* (Agassiz). This species is recorded from Lake Superior region by Meek and Clark (1902), Girard (1851), Ruthven (1909), and Nash (1908).

SUMMARY AND CONCLUSIONS.

The field work of 1913 established the occurrence of thirty species of fish in the Whitefish Point region. That at least thirty-four others belong to the fauna is very evident from testimony of residents and published data. Each of the species of fish found in the region by the writer may be considered common there with the exception of the following: tullibee, rainbow trout, horned dace, golden shiner, Menona top minnow, long-eared sunfish (?), black-sided darter, and Johnny darter.

Of the thirty species of fish taken, eighteen are common and generally distributed in the region of the Great Lakes and in the Central States generally. Only eight are boreal in distribution. These are Saginaw Bay herring, tullibee, Labrador whitefish, Menominee whitefish, long-nosed sucker, *Leuciscus neogaeus*, Menona top minnow, and nine-spined stickleback. The rainbow trout exists in the region through artificial introduction.

Within the Whitefish Point area, the different species are restricted in distribution, forming five rather distinct faunas, which are (1) that of the Lake Superior shoal, (2) of the beach ponds, (3) of the west group of marsh lakes, (4) of the east group of marsh lakes, and (5) of Shelldrake River and Lake. No one species was found in all of these

habitats and but few are at all generally distributed. The species of widest habitat range are common perch, brook stickleback, common sculpin and Cayuga minnow. Some very limited in distribution are sunfish (Lepomis), Menona top minnow, golden shiner, long-nosed dace, black-sided darter, and Johnny darter.

Of the fifteen species of fish taken from the Lake Superior shoal, seven were not found in the inland bodies of water. These were lake herring, tullibee, Labrador whitefish, Menominee whitefish, rainbow trout, nine-spined stickleback, and burbot. One burbot, however, was found in Vermilion Creek right at its mouth, where Lake Superior shoal conditions were present.

Of the twenty-three species taken in the inland bodies of water, fifteen were not found in Lake Superior. These were, red-bellied dace, silvery minnow, black-head minnow, Cayuga minnow, horned dace, golden shiner, black-nosed dace, *Leuciscus neogæus*, mud minnow, Menona top minnow, common pike, Iowa darter, black-sided darter, Johnny darter, and the sunfish.

The species common to Lake Superior and the inland habitats are: brook trout, spot-tailed minnow, long-nosed dace, long-nosed sucker, common sucker, brook stickleback, common perch, and common sculpin.

Twenty species of fish were found in the marsh lakes and their outlet streams, of these five were abundant in the west group of lakes but scarce or absent in the east group. These were, red-bellied dace, silvery minnow, black-head minnow, common sucker, and brook stickleback.

Shelldrake River and Shelldrake Lake have a fauna very different from that of the marsh lakes and Lake Superior, for of the eleven species caught there, three (blacksided darter, Johnny darter, and the sunfish) appeared peculiar to the habitat and two (long-nosed dace and spot-tailed minnow) were scarce elsewhere but common in the Shelldrake region.

It was not possible in the time available to examine in detail the relations existing between the fish and their environment and thus to determine the ecological factors governing the distribution, but the general environmental features influencing the fish life of the region are climate, bottom soil, plants, and aquatic animals.

Climate. The long winters and cold nights even in summer subject the fish, especially those of the shallow lakes and ponds, to much low temperature. This undoubtedly affects their numbers, size, and activity. Fish are said to leave the shallow water near the shore of Lake Superior on the approach of storms. None could be found there during bad weather, and they only became numerous during rather

prolonged periods of quiet. Residents say, however, that herrings are thrown ashore at times by the waves. Water movements in all probability disturb the sand down to a depth of twenty-six feet as they do in Lake Michigan (Shelford 1913, page 74).

Bottom material. No definite relations of bottom soil to fish could be made out, yet certain types of bottom were preferred to others by certain fish. In Lake Superior the submerged pebble zone was avoided by the schools of free swimming young herring, perch, and suckers, as well as by sticklebacks and some others, while sculpins and burbots evidently preferred the stony area. In the marsh lakes, there was noted a marked preference for the muck bottoms on the part of all species. The loose, black soil undoubtedly harbored much food and furnished hiding places for the small fish, although none were seen retreating into it.

Plants. The larger aquatic plants are used by the fish for protection and seclusion. Growths of stonewort, water weeds, tape grass, and pondweeds were found utilized in this way. Partly submerged sweet gale, sedges, and many other plants of similar habits also furnished concealment for fish; pike lie in ambush about their submerged bases. Filamentous algae was eaten by common suckers, young whitefish, brook sticklebacks, and sculpins, according to the writer's observations, and diatoms were found in many digestive canals, especially those of common suckers, Cayuga minnows, silvery minnows, and black-head minnows. The food value of these little plants is questionable.

Invertebrates. The invertebrates are an important part of the fish environment when they serve as food or become parasites. The principal forms eaten by fish in the region are entomostracans, chironomid larvae, black-fly larvae, May-fly larvae, caddice-worms, amphipods, and leeches. Entomostracans constituted the chief food of young herring, young whitefish, and nine-spined sticklebacks on the Lake Superior shoal. All were feeding on the same forms, which belonged chiefly to the Crustacean genera, *Diaptomus*, *Bosmina*, and *Cyclops*. Small suckers, and perch, on this shoal, were also eating these forms to a considerable extent. Chironomid larvae are extensively taken by the fish of the Whitefish Point region; they seemed especially important to bottom feeders, suckers, sculpins and burbots. Black-fly larvae appeared to be the sole food for the colony of long-nosed dace living near the mouth of Vermilion Creek. Sculpins were also eating them in Shelldrake River. Amphipods made up most of the stomach contents of the few whitefish caught in the deeper part of the shoal. Leeches were eaten by large perch in the marsh lakes.

Vertebrates. The vertebrates are especially marked factors in the fish environment when they prey upon fish. Brook trout, rainbow

trout, common pike, and sculpins were found eating other fish. Of these the most important destroyers seem to be the common pikes, for they are numerous and often of a large size. Sculpins appear to eat other fish extensively in the region, including members of their own species. Some fish-eating birds are common. These are loons, blue-herons, night herons, bitterns, kingfishers, mergansers, and grebes. Kingfishers frequently attack schools of small fish. Minks are considered common in the region. If they are, many fish are probably eaten by them. Fish probably to some extent destroy other vertebrates for large pikes are said to catch young muskrats and young ducks in the marsh lakes.

Fish affect each other through competition for food. A conspicuous instance of this in the Whitefish Point region is in the case of the hosts of nine-spine sticklebacks eating the same food as the much-less numerous little whitefish and herring and other species of the shallow water.

Most of the species of fish in the Whitefish Point region influence man in unimportant ways. Whitefish, herring, and brook trout, furnish food for residents and the first two are of much commercial value at Whitefish Point, where many tons of them are taken each year and are the cause of a very important fishery there. Man and the beaver have varied the character of the fish habitats through dams, channels, and other structures that they have built about the marsh lakes.

BIBLIOGRAPHY.

Abbott, C. C. 1875

1875. Notes on Some fishes of the Delaware River. Report of the Comm. of Fish and Fisheries, 1875-1876; 825-845.

Adams, A. L.

1873. The Lake Trout. Report of the Comm. of Fish and Fisheries, 1872-1873; 357-362.

Adams, C. C. and others.

1906. An Ecological Survey in Northern Michigan. Report of the State Board of Geological Survey of Michigan for 1905.

1909. An Ecological Survey of Isle Royale, Lake Superior. Report of the State Board of Geol. Survey of Michigan, for 1908.

1913. Guide to the Study of Animal Ecology. The Macmillan Co., New York.

Agassiz, L.

1850. Lake Superior: its Physical Character, Vegetation and Animals compared with those of other and similar Regions. Boston.

Allen, A. A.

1913. The Red-winged Blackbird. A Study of the Ecology of a

Cat-tail Marsh. Proc. Linnean Soc. of New York for 1911-13; 1-128, Pl. 1-22.

Baker, F. C.

1910. The Ecology of the Skokie Marsh Area with Special Reference to Mollusca. Bull. Ill. State Laboratory of Natural History 8, Art. 4.

Barlow, A. E.

1899. Report on the Fish of the Nipissing and Temiscaming Region, Ontario. Report of the Geol. Surv. of Canada, 10.

Barrows, W. B.

1912. Michigan Bird Life. Mich. Agr. College, E. Lansing, Mich.

Beal, W. J. and Wheeler, C. F.

1892. Michigan Flora. Thirteenth Annual Report of the Secretary of the State Board of Agriculture.

Bean, T. H.

1901. Food and Game Fishes of New York. Seventh Report of the Forest, Fish, and Game Comm. of New York. 251-460.

Bell, Robert

1897. Recent Explorations to the South of Hudson's Bay. Geographical Journal, 10; 1-19.

Bollman, H.

1890. A Report upon the Fishes of Kalamazoo, Calhoun, and Antrim Counties, Michigan. Bull. of the U. S. Fish Comm. 8; 219-225.

Clark, F. N.

1900. Methods and Results in Connection with the Propagation of Commercial Fishes in the Great Lakes. Trans. Am. Fish. Soc., 29th. Ann. Meeting; 88-95.

1902. A Successful Year in the Artificial Propagation of Whitefish. Trans. Am. Fish. Soc. 31st. Ann. Meeting; 97-106.

1904. Commercial Fish and Fisheries. Sixth Report of the Mich. Acad. Sciences; 65-68.

Cope, E. D.

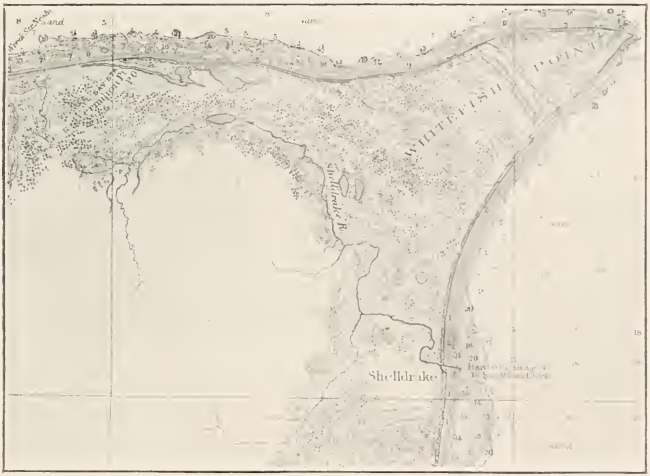
1864. Partial Catalogue of the Cold-blooded Vertebrata of Michigan. Proc. Acad. Nat. Sci. Philadelphia, 1864; 276-285.

1866. Synopsis of the Cyprinidae of Pennsylvania. Trans. Am. Philos. Soc. 13; N. S. Art. 13; 351-399.

Cowles, H. C.

1899. The Ecological Relations of the Vegetation on the Sand Dunes of Lake Michigan. Bot. Gazette 27; numbers 2, 3, 4, and 5.

1900. The Physiographic Ecology of Northern Michigan. Science, N. S. 12; 706-709.



MAP OF THE WHITEFISH POINT REGION CHIPPEWA COUNTY, MICHIGAN

A. LAKE SUPERIOR BEACH AT VERMILION. UPPER AND LOWER BEACH SHOWN; THE LATTER WITH *AMMOPHILA ARENARIA* ZONE, SHOWN CHIEFLY IN THE FOREGROUND.

B. LAKE SUPERIOR BEACH WITH SAND RIDGE CROSSED BY CRANBERRY CREEK, JUST EAST OF VERMILION.

A. LAKE SUPERIOR BEACH, LOOKING EAST TOWARD VERMILION, DURING A STORM. SHOWING FORMATION OF TEMPORARY POOLS BY WAVES.

B. SMALL PORTION OF LAKE SUPERIOR BEACH SHOWING PEBBLE ZONE AND SMALL TEMPORARY POND

A. LAKE SUPERIOR BEACH WITH DUNES OF THE FIRST SAND RIDGE.

B. CRANBERRY CREEK (STATION 30). LOOKING NORTH AND DOWN STREAM. SHOWING A PART OF THE BEACH POOL FORMED BY IT (STATION 31).

A. POND ON LAKE SUPERIOR BEACH (STATION 31) FORMED BY CRANBERRY CREEK.

B. BEAVER DAM AND POND ON MASON'S CREEK (STATION 171)

A. BEACH POND IN THE COURSE OF MASON'S CREEK.

B. MARSH BORDERING MASON'S CREEK (STATION 172) ON LAKE SUPERIOR BEACH

A. LOOKING SOUTHWEST FROM HIGH SAND DUNE NEAR STATION 101, SHOWING MARSH AND SAND RIDGES WITH UPLAND IN DISTANT BACKGROUND.

B. MARSH LAKES, LOOKING SOUTHEAST FROM THE HIGH DUNE NEAR STATION 101.

A. CHANNEL EAST FROM BEAVER LAKE (STATION 90).

B. CHANNEL OF VERMILION LAKE (STATION 25).

A. MARSH BAY OF BEAVER LAKE (STATION 55), LOOKING SOUTHWEST (LAKEWARD).

B. THE SAME, LOOKING SOUTH.

A. MARSH BAY OF BEAVER LAKE (STATION 52), LOOKING NORTHEAST

B. NORTHWEST SHORE OF BEAVER LAKE (STATION 59), LOOKING NORTHEAST.

A. SPRUCE LAKE, LOOKING NORTHWEST (STATION 71).

B. STATION 84, SPRUCE LAKE, LOOKING EAST. FLOATING MATS OF STONE WORT ON THE SURFACE.

A. STATION 85, SPRUCE LAKE, LOOKING SOUTH ACROSS THE EAST END OF THE LAKE.

B. MARSHY NORTH SHORE OF VERMILION LAKE

A. SMALL LAKE AND WOODED SAND RIDGE ABOUT A HALF MILE EAST OF VERMILION (STATION 106), LOOKING NORTHEAST.

B. WEST END OF THE SMALL LAKE SHOWN IN A STATION 101, LOOKING EAST

A. MITTEN LAKE, STATION 116, LOOKING EAST.

B. VERMILION CREEK AT VERMILION. GREAT BLUE HERON FEEDING.

A. SHELLDRAKE LAKE, LOOKING SOUTHWEST

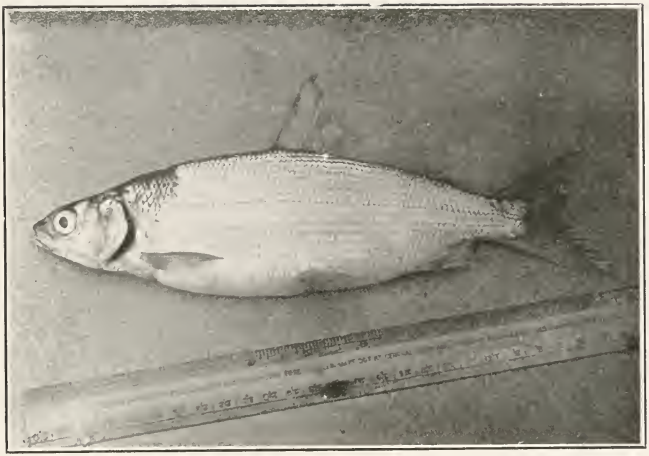
B. NORTHWEST SHORE OF SHELLDRAKE LAKE, LOOKING NORTHEAST (STATION 142).

A. SHELLDRAKE RIVER AND PORTION OF WOODED SWAMP, LOOKING DOWN STREAM FROM A HIGH, NORTH STREAM BANK.

B. PORTION OF SHELLDRAKE RIVER JUST SOUTH OF VERMILION

A. SHELLDRAKE RIVER JUST SOUTH OF SHELLDRAKE LAKE, LOOKING SOUTH.

B. LONG-NOSED DACE, *RHINICHTHYS CATARACTAE*.



A. TULLIBEE, *LEUCICHTHYS TULLIBEE* (?) CAUGHT AT STATION 2, LAKE SUPERIOR.

B. YOUNG WHITEFISH, *COREGONUS CLUPEAFORMIS* (POSSIBLY *ALBUS*) LENGTH OF LARGEST ABOUT THREE INCHES, CAUGHT AT STATION 1, ON LAKE SUPERIOR SHOAL.

Cox, I. 9.
1896. Fishes of Southwestern Minnesota. Report of the U. S. Comm. of Fish and Fisheries for 1894; 605-616.
1897. A Preliminary Report on the Fishes of Minnesota. Geol. and Nat. Hist. Survey of Minn. Zool. Series III.

Davis, C. A.
1907. Peat, Essays on its Origin, Uses, and Distribution in Michigan. Report of the Mich. State Board of Geol. Survey for 1906; 95-395.

Dickerson, F. B.
1904. The Benefits of the Propagation of Game Fish to the State of Michigan. Sixth Report of the Michigan Academy of Science; 69-71.

Dodge, C. K.
1913. The Flowering Plants, Ferns, and their Allies of Mackinac Island. Fifteenth Report of the Mich. Acad. Sci.; 218-237.

Downing, S. W.
1904. The Whitefish; Some Thoughts on its Propagation and Protection. Trans. Am. Fish. Soc., 33d. Ann. Meeting.
1908. Plans for Promoting the Whitefish Production of the Great Lakes. Bull. of the U. S. Bureau of Fisheries 28; 629-695.

Ellis, Max M.
1914. Fishes of Colorado. Univ. of Colorado Studies, II, no. 1; 1-136, Pl. 1-12.

Evermann, B. W.
1894. The Investigation of Rivers and Lakes with Reference to Fish Environment. Bull. of the U. S. Fish Comm. for 1894; 69-73.
1900. Bait Minnows. Sixth Report of the New York Forest, Fish, and Game Comm.; 307-356.
1901. List of the Species of Fish Known to Occur in the Great Lakes and their Connecting Waters. Bull. of the U. S. Fish Comm. 21; 95-96.

Evermann, B. W. and Goldsborough, E. I.
1907. A Check List of the Fresh-water Fishes of Canada. Proc. of the Biol. Soc. of Washington; 20; 89-120.

Evermann and Latimer, H. B.
1910. The Fishes of the Lake of the Woods and Connecting Waters. Proc. U. S. Nat. Mus. 39; 121-136.

Evermann, B. W. and Smith, H. M.
1896. The Whitefishes of North America. Report of the U. S. Comm. of Fish and Fisheries for 1894; 283-324. Pl. 1-17.

Faull, J. H.
1913. The Natural History of the Toronto Region, Ontario, Canada,

including an account of the Fishes by C. W. Nash. Canadian Institute, Toronto.

Forbes, S. A.

1878. The Food of Illinois Fishes. Bull. 2 of the Ill. State Lab. Nat. Hist.; 73-89.

1880. The Food of Fishes: Acanthopteri. Bull. Ill. State Lab. Nat. Hist. 1; no. 2; 19-70.

1880a. On the Food of Young Fishes. Bull. Ill. State Lab. Nat. Hist. 1; no. 3; 71-85.

1883. Food of the Smaller Fresh-water Fishes. Bull. Ill. State Lab. Nat. Hist. no. 6; 65-95.

1883a. The First Food of the Common Whitefish. Bull. Ill. State Lab. Nat. Hist. no. 6; 95-109.

1888. Studies of the Food of Fresh-water Fishes. Bull. Ill. State Lab. Nat. Hist., no. 2, Art. VII; 433-473.

1888a. On the Food Relations of Fresh-water Fishes; A Summary and Discussion. Bull. Ill. State Lab. Nat. Hist. 2, Art. VIII; 475-538.

1888b. Food of the Fishes of the Mississippi Valley. Trans. Am. Fisheries Soc., 17th Ann. Meeting; 1-17.

1890. On Some Lake Superior Entomostraca. Report of the Comm. of Fish and Fisheries for 1887; 701-718. Pl. 1-4.

1890a. Preliminary Report upon the Invertebrate Animals Inhabiting Lake Geneva and Mendota, Wisconsin. Bull. U. S. Fish Comm. VIII; 473-487.

1909. On the General and Interior Distribution of Illinois Fishes. Bull. Ill. State Lab. Nat. Hist. 8; Art. 3.

1914. Fresh-water Fishes and their Ecology. Urbana, Ill. pp. 1-19. Pl. 1-10, Maps 21.

Forbes, S. A. and Richardson, R. E.

1908. The Fishes of Illinois. Natural History Survey of Illinois. Ichthyology.

Found, W. A. 1912.

1912. Fish Culture in Canada. Report of the Comm. of Conservation of Canada; 140-153.

Fowler, H. W.

1908. A Synopsis of the Cyprinidae of Pennsylvania. Proc. Acad. Nat. Sci. Phil., 60; 517-553.

1911. Notes on Salmonoid and Related Fishes. Proc. Acad. Nat. Sci. Phil. 63; 551-571.

Gates, F. C.

1912. The Vegetation of the Region in the Vicinity of Douglas

Lake, Cheboygan County, Michigan, in 1911. Fourteenth Report of the Michigan Academy of Science, 46-106.

Gill, Theodore

1904. A Remarkable Genus of Fishes—the Umbras. Smithsonian Miscellaneous Collections (Quarterly Issue) 45; 295-305.

1905. The Sculpin and its Habits. Smith. Misc. Coll. (Quart. Issue) 47; 348-359.

1905a. The Family of Cyprinids and the Carp as its type. Smith. Misc. Coll. (Quart. Issue) 48; 195-217.

1907. Some Noteworthy Extra-European Cyprinids. Smith. Misc. Coll. (Quart. Issue) 48; 297-340.

1908. The Miller's Thumb and its Habits. Smith. Misc. Coll., 52, pt. 1; 101-116.

Goode, G. Brown

1884. Natural History of Aquatic Animals, Sec. 1. U. S. Comm. of Fish and Fisheries.

1886. American Fishes. Boston.

Goode, G. Brown and Associates

1887. The Fisheries and Fishing Industries of the United States. U. S. Comm. of Fish and Fisheries, Washington.

Halkett, A.

1913. Check List of the Fishes of the Dominion of Canada and Newfoundland; 7-138, Pl. 1-14, Ottawa, Can.

Hankinson, T. L.

1908. A Biological Survey of Walnut Lake, Michigan. Report of the State Board of Geol. Surv. for 1907.

1910. Ecological Notes on the Fishes of Walnut Lake, Michigan. Trans. of the Am. Fish. Soc. for 1910; 195-206.

1914. Young Whitefish in Lake Superior. Science, N. S. 40; 239-240.

Harper, R. M.

1913. Car-window Notes on the Vegetation of the Upper Peninsula. Fifteenth Report of the Mich. Acad. Sci.; 193-198.

Hart, C. A.

1895. On the Entomology of the Illinois River and Adjacent Waters. Bull. Ill. State Lab. Nat. Hist. 4; Art. VI.

Hart, C. A. and Gleason, H. A.

1907. On the Biology of the Sand Areas of Illinois. Bull. Ill. State Lab. of Nat. Hist. 7, art. 7.

Heimburger, H. V.

1913. The Factors that Determine the Distribution of *Boleosoma nigrum* in Douglas Lake, Cheboygan County, Michigan. Fifteenth Report of the Mich. Acad. Sci.; 120.

Henshall, J. A.
1905. On the Protection of Fish in Inland Waters. Trans. 34th Ann. Meeting Am. Fish. Soc.; 139-147.

Herrick, C. L. and Turner, C. H.
1895. Synopsis of the Entomostraca of Minnesota. Second Report of the State Zoology of Minn. Geol. and Nat. Hist. Survey of Minn. Zool. Series II.

Jackson, C. T.
1884. Fish and Shells from Lake Superior. Proc. Boston Soc. Nat. Hist. 1; 198.

Joncas, L. Z.
1894. The Fisheries of Canada. Bull. of the U. S. Fish. Comm. for 1893; 341-348.

Jordan, D. S.
1905. A Guide to the Study of Fishes, New York.

Jordan, D. S. and Evermann, B. W.
1896. The Fishes of North and Middle America. Bull. 47 of the U. S. Nat. Museum.
1902. American Food and Game Fishes, New York.
1909. Description of Three New Species of Cisco or Lake Herring (*Argyrosomus*) from the Great Lakes of America with a Note on the Species of Whitefish. Proc. U. S. Nat. Mus. 36; 165-172.
1911. A Review of the Salmonoid Fishes of the Great Lakes with Notes on the Whitefishes of other Regions. Bull. of the Bur. of Fisheries 29; 1-41. Pl. 1-7.

Juday, C.
1907. A Study of Twin Lakes, Colorado with Special Consideration of the Food of Trouts. Bureau of Fisheries Doc. 616.

Kendall, W. C.
1894. Notes on the Fresh-water Fishes of Washington Co., Maine. Bull. of the U. S. Fish Comm. for 1894; 43-54.
1903. Notes on Some Fresh-water Fishes from Maine. Bull. U. S. Comm. of Fish and Fisheries; 353-368.

Kendall, W. C. and Goldborough, E. L.
1908. The Fishes of the Connecticut Lakes and Neighboring Waters, with Notes on their Plankton Environment. Bur. of Fisheries Doc. 633.

Kirsch, P. H.
1894 Report upon the Explorations made in Eel River Basin in the Northeastern Part of Indiana in the summer of 1892. Bull. U. S. Fish Comm. for 1894; 31-41.

Kumlein, L.
1887. The Fisheries of the Great Lakes. In U. S. Comm. of Fish and Fisheries publication on the Fisheries and Fishery Industries of the U. S.; 757-769.

Leathers, A. L.
1911. A Biological Survey of the Sand Dune Region on the South Shore of Saginaw Bay Michigan: Fish. Mich. Geol. and Biol. Survey, Publication 4, Biological Series 2; 243-255.

Leverett, Frank
1904. Review of the Glacial Geology of the Southern Peninsula of Michigan. Sixth Report of the Michigan Academy of Science; 100-110.
1910. Outline of the History of the Great Lakes. Twelfth Report of the Michigan Academy of Science; 19-42.
1911. Surface Geology of the Northern Peninsula of Michigan. Mich. Geol. and Biol. Survey Pub. 7, Geol. Series 5; 8-91.

Marsh, C. D.
1897. Cyclopidae and Calanidae of Lake St. Clair. Bull. Mich. Fish Comm. no. 5.
1903. The Plankton of Lake Winnebago and Green Lake. Wisconsin Geol. and Nat. Hist. Survey. Bull. XII, Science Series no. 3; 67-69.

Marshall, W. S. and Gilbert, N. C.
1905. Notes on the Food and Parasites of Some Fresh-water Fishes from the Lakes of Madison, Wis. Appendix to the Report of the Comm. of Fisheries to the Secretary of Commerce and Labor for the year ending June 30, 1904; 513-522.

Mather, F.
1886. Memoranda Relating to Adirondack Fishes with Descriptions of New Species. Twelfth Report of the Adirondack Survey of New York.

Meek, S. E. and Clark, H. W.
1902. Notes on a Collection of Cold-blooded Vertebrates from Ontario. Field Mus. of Nat. Hist. Pub. 67. Zool. Series 3, no. 7.

Meek, S. E. and Hildebrand, S. F.
1910. A Synoptic List of the Fishes Known to Occur within Fifty Miles of Chicago. Field Mus. of Nat. Hist. Pub. 142. Zool. Series 7, no. 9.

Miall, L. C.
1895. The Natural History of Aquatic Insects. Macmillan Co., New York.

Michael, E. L.
1904. Catalogue of Michigan Fish. Bull. of the Mich. Fish Comm. no. 8.

Milner, J. W.
1872. Report on the Fisheries of the Great Lakes; the Result of Inquires Prosecuted in 1871 and 1872. Report of the U. S. Fish Comm., 1872-73; 1-78.

Milner, J. W. and others
1872. Miscellaneous Notes and Correspondence Relative to the Whitefish. Report of the U. S. Fish Comm. 1872-1873; 79-89.

Moore, C. H.
1893. Report of the Statistical Agent. Tenth Report Mich. Fish Comm.; 7-39.
1895. Statistics of the Commercial Fisheries. Eleventh Report of the Board of Fish Commissioners of Michigan; 44-53.

Moore, J. P.
1912. Classification of the Leeches of Minnesota. Geol. and Nat. Hist. Survey of Minn. Zool. Series V; 1-128. Pl. 1-6.

Nash, C. W.
1908. Vertebrates of Ontario. Dep't. of Education, Toronto.
1913. Natural History of the Toronto Region, Fishes. (See Faull, 1913, above).

Needham, J. G.
1908. Report on the Entomologic Field Station Conducted at Old Forge, N. Y., in the summer of 1905. N. Y. State Museum Bulletin 124; 156-263. Pl. 1-32.

Needham, J. G. and Betten, C.
1901. Aquatic Insects of the Adirondacks, N. Y. State Museum Bull. 47.

Needham, J. G. and Hart, C. A.
1901. The Dragon-flies (Odonata) of Illinois. Part I. Bull. Ill. State Lab. Nat. Hist. 6; art. 1.

Needham, J. G. and MacGillivray, A. D., Johannsen, O. A., and Davis, E. C.
1903. Aquatic Insects of New York State. Bull. 68, N. Y. State Museum.

Newcombe, F. C.
1904. A Natural History Survey of Michigan. Sixth Report of the Michigan Academy of Science; 28-36.

Patton, M. J.
1912. Whitefish of the Great Lakes. Report of the Comm. of Conservation of Canada for 1912; 13-24.

Pond, R. H.
1902. The Role of the Larger Aquatic Plants in the Biology of Fresh Water. Trans. Am. Fish. Soc. for 1902.

Pope, T. E. B.
1908. Devil's Lake, North Dakota. A Study of Physical and Biological Conditions with a View to Acclimatization of Fish. Bur. of Fisheries Doc. 634.

Post, H.
1894. Fish Culture in Michigan. Bull. U. S. Fish Comm. for 1893; 201-211.

Reighard, J. E.
1894. A Biological Examination of Lake St. Clair. Bull. Mich. Fish Comm. no. 4.
1896. A Biological Examination of Lake Michigan in the Traverse Bay Region. Bull. Mich. Fish Comm. no. 6.
1906. On the Identification for Legal Purposes of Mutilated or Dressed Specimens of Whitefish and Herring from the Great Lakes. Trans. Am. Fisheries Soc. 35th Ann. Meeting; 47-58.
1908. The Photography of Aquatic Animals in their Natural Environment. Bull. of the Bur. of Fisheries, 27; 41-68.
1908a. Methods of Studying the Habits of Fishes with an account of the Breeding Habits of the Horned Dace. Bull. of the Bur. of Fisheries 28; 1111-1136.
1913. Improvement of Fishing through a Knowledge of the Breeding Habits of Fishes. Trans. Am. Fish. Soc. at its 43d Ann. Meeting; 97-110.
1913a. A Plea for the Preservation of Records Concerning Fish. Trans. Am. Fisheries Soc. at its 43d Ann. Meeting; 105-110.
1913b. The Breeding Habits of the Log-Perch (*Percina caprodes*). Fifteenth Report of the Mich. Acad. Sci.; 104-105.

Reighard, Paul
1908. A Plan for Promoting the Whitefish Production of the Great Lakes. Bull. Bur. of Fisheries, 28; 645-695.

Richardson, John
1836. Fauna Boreali-americana or the Zoology of the Northern Parts of British America. Part III, the Fish. London.

Ridgway, Robert
1912. Color Standards and Color Nomenclature. Washington, D. C.

Riley, C. F. C.
1912. Observations on the Ecology of Dragon-fly Nymphs; Re-

action to Light and Contact. Annals of the Entomological Society of America, 5, no. 3; 273-292.

Robinson, B. L. and Fernald, M. L.

1908. Gray's New Manual of Botany, Seventh Edition. Am. Book Co . Cincinnati.

Ruthven, A. G.

1904. Notes on the Mollusks, Reptiles, and Amphibian of Ontonagon County, Michigan. Sixth Report of the Michigan Academy of Science; 188-192.

1909. The Cold-blooded Vertebrates of Isle Royale. Report of the Board of Geol. Survey of Michigan for 1908; 329-333.

1911. A Biological Survey of the Sand Dune Region of the South Shore of Saginaw Bay, Michigan. Mich. Geol. and Biol. Survey Pub. 4, Biol. Series 2.

1913. Report upon the Progress of the Biol. Work of the Michigan Geological and Biological Survey During the Year 1912-1913.

1913a. Report of the Director of the Museum of Zoology of the University Board of Regents. University Bulletin, Ann Arbor, Mich. 15, N. S., no. 9.

1914. Report of the Director of the Museum of Zoology of the University of Michigan to the Board of Regents. University Bulletin 16, no. 20.

Ruthven, A. G. and Thompson, C. and Thompson, H.

1912. The Herpetology of Michigan. Pub. 10, Biol. Series 3 of the Mich. Geol. and Biol. Survey.

Shelford, V. E.

1911. Ecological Succession Biol. Bulletin, 21, no. 1; 9-35.

1911a. Ecological Succession II. Pond Fishes. Biol. Bull. 21, no. 3; 127-151.

1911b. Ecological Succession III. A Reconnaissance of its Causes in Ponds with Particular Reference to Fish. Biol. Bull. 22, no. 1; 1-38.

1913. Animal Communities in Temperate America. Chicago.

Smith, B. G. 1908.

1908. Spawning Habits of *Chrosomus erythrogaster*. Biol. Bull. 14, no. 6; 9-18.

Smith, S. I.

1873. Sketch of the Invertebrate Fauna of Lake Superior. Report of the Comm. of Fish and Fisheries, 1872-73; 690-707.

1873a. Food of Fresh-water Fishes. Report of the Comm. of Fish and Fisheries 1872-73; 708-709.

Smith, H. M.
1894. Notes on Two Hitherto Unrecognized Species of American Whitefishes. Bull. of the U. S. Fish Comm. for 1894; 1-13.

Smith, H. M. and Snell, M.
1887. Review of the Fisheries of the Great Lakes in 1885. Report of the U. S. Comm. of Fish and Fisheries for 1887. Part XV; 3-333.

Strang, J. J.
1854. Some Remarks on the Natural History of Beaver Islands, Michigan. Ninth Report of the Smithsonian Institution; 282-288.

Suckley, George
1861. On the North American Species of Salmon and Trout. Report of the U. S. Fish Comm. 1872-73; 91-160.

Taylor, F. B.
1912. The Glacial and Postglacial Lakes of the Great Lake Region. Smithsonian Institution Report for 1912; 291-327.

Thompson, C. and Thompson, H.
1913. Results of the Shiras Expedition to Whitefish Point, Michigan. Fifteenth Report of the Michigan Academy of Science; 215-217.

Townsend, C. H.
1902. Statistics of the Fisheries of the Great Lakes. Report of the Comm. of Fish and Fisheries for 1902; 575-657.

Tracy, H. C.
1910. Annotated List of the Fishes Known to Inhabit the Waters of Rhode Island. Fortieth Ann. Report of the Commission of Inland Fisheries of Rhode Island.

United States Bureau of Fisheries.
1909-1913. Distribution of Fish and Eggs. Washington, D. C.
1911-1914. Annual Reports of the Commissioner of Fisheries to the Secretary of Commerce and Labor. Bur. of Fisheries Documents, Washington, D. C.

Van Hise and Leith, C. K.
1911. Geology of the Lake Superior Region. U. S. Geol. Survey Monographs, 42.

Verrill, A. E.
1873. Synopsis of the North American Fresh-water Leeches. Report of the Comm. of Fish and Fisheries, 1872-73; 662-692.

Vestal, A. E.
1913. An Associational Study of Illinois Sand Prairie. Bull. of the Ill. State Lab. of Nat. Hist., 10, Art. 1.

Wagner, G.
1908. Notes on the Fish Fauna of Lake Pepin. Trans. of the Wis. Acad. Sci., Arts, and Letters; 16, pt. 1; 23-37.
1910. *Argyrosomus johannae,* a new Species of Cisco from Lake Michigan. Science N. S. 31, 957-958.
1910a. On the Stickleback of Lake Superior. Science, N. S. 32; 28-30.

Wakeham, W. and Rathbun, R.
1896. Report of the Joint Commission Relative to the Reservation of the Fisheries in the Waters Contiguous to Canada and the United States. Ottawa, Can.

Walker, Bryant
1894. Review of our Present Knowledge of the Molluscan Fauna of Michigan. Detroit.
1898. The Distribution of the Unionidae in Michigan. Detroit.

Ward, H. B.
1896. The Food Supply of the Great Lakes; and some Experiments on its Amount and Distribution. Trans. of the Am. Microscopical Society, 17; 242-260.
1900. A plea for the Study of Limnology. Trans. Am. Micro. Soc. 21; 201-212.

Welch, P. S.
1914. Habits of the Larva of *Bellura melanopyga* Grote. Biol. Bull. Aug. 1914; 97-113.

Wheeler, C. F. and Smith, E. F.
1881. Catalogue of the Phaenogamous and Vascular Cryptogamous Plants of Michigan. Lansing.

Whitford, H. N.
1901. The Genetic Development of the Forests of Northern Michigan. A Study of Physiographic Ecology. Botanical Gazette 31; 289-325.

Wilson, C. H.
1912. The Whitefish. Trans. Am. Fish. Soc. at its 43d Meeting; 89-100.

Woolman, A. J.
1896. Ichthyological Investigations. Report of the U. S. Comm. of Fish and Fisheries for 1893; 343-373.

INDEX.

INDEX

To the generic names used in this report.

A.

	Page
Abies	114
Abramis	21, 23, 147
Acanthocinus	99
Acemaeodera	70
Acer	114
Acidota	85
Acilus	82
Acipenser	153
Acmaeops	98
Acoptus	107
Acris	62
Adalia	85
Adelocera	89
Adoxus	100
Aeshna	48, 49, 50, 55, 56, 117, 126, 132, 135
Agabetes	81
Agabus	81
Agonoderus	79
Agrilus	92
Agrion	42, 43, 55, 56, 57
Agriotes	90
Agyrosomus	32, 33, 34, 35
Alaus	89
Allecula	103
Alnus	114
Alosa	154
Amelanchier	114
Amara	74, 75
Ambloplites	27, 29, 31, 32, 33, 34, 35, 36, 155
Ameiurus	27, 28, 29, 31, 32, 33, 34, 35, 155
Amia	29, 33, 153
Anabaena	115
Anaphalis	114
Anaspis	104
Anatis	86
Anax	40, 49, 50, 55, 56
Andromeda	116
Anisodactylus	80
Anomala	96
Anopheles	116, 134
Anthicus	105
Anthocomus	93
Anthrenus	87
Aphodius	94, 95
Aphonus	96
Apiodinotus	156
Apocynum	114
Aralia	114
Arctocorisa	117, 132, 138
Arctostaphylos	114
Arhopalus	98
Arrhenoplita	103
Asaphes	91
Asemum	97
Ataenius	94
Athous	91

B.

Babia	100
Badister	75
Bagous	107
Ballamira	98
Basiaeschna	49, 55, 56
Batrachospermum	20
Bellura	116
Betula	114
Boyeria	49, 55, 56
Belaninus	107

Page

Bembidium ... 73
Berosus ... 83
Blapstinus ... 103
Blethisa ... 72
Bolboceras ... 95
Boleosoma ... 30, 33, 35, 151
Boletobius ... 85
Boletophagus ... 103
Boletotherus ... 103
Bosmina ... 117, 141, 150, 158
Bostrichus ... 93, 94
Brachyacantha ... 86
Brachylobus ... 78
Brachynus ... 77, 78
Brachys ... 92
Brasenia ... 14, 16, 17
Brontes ... 86
Bruchus ... 102
Bufo ... 62, 118, 138
Bupestris ... 91, 92
Byrrhus ... 88

C.

Calathrus ... 75
Callida ... 77
Calligrapha ... 101
Calloides ... 98
Calosoma ... 72
Cambarus ... 21, 117, 135, 137, 138
Campanula ... 115
Canthon ... 94
Carabus ... 72
Cardiophorus ... 89
Carex ... 115
Casnomia ... 77
Castalia ... 32
Castor ... 118
Catostomus ... 14, 17, 18, 20, 22, 28, 29, 30, 31, 33, 34, 35, 36, 144
Celithemis ... 53, 54, 55, 56
Centrinus ... 107
Ceratopodon ... 117, 133
Cercyon ... 84
Chalepus ... 102
Chamaedaphne ... 15, 20, 40, 115
Chelydra ... 63
Chelymorpha ... 102
Chilocorus ... 86
Chion ... 97
Chironomus ... 117, 133, 151
Chlaenius ... 78
Chorophilus ... 62
Chrosomus ... 14, 17, 19, 20, 22, 145
Chrysemys ... 63, 118
Chrysochus ... 100
Cicindela ... 71, 72, 116
Cis ... 94
Cladonia ... 114
Clerus ... 93
Clivinia ... 73
Clytanthus ... 98
Coccinella ... 85
Coelambus ... 80
Coeliodes ... 107
Collops ... 93
Colymbetes ... 81
Conotrachelus ... 107
Copris ... 94
Coptotomus ... 81, 125
Cordulia ... 51, 52, 55, 56
Coregonus ... 139, 140, 141
Corixa ... 117, 137
Cornus ... 114
Corymbites ... 91
Cossonus ... 108
Cotalpa ... 96
Cottus ... 32, 33, 152
Couesius ... 14, 17 19, 23, 155
Cratoparis ... 108
Creniphilus ... 83
Creophilus ... 84
Crocephalus ... 97
Cristivomer ... 154
Cryptobrium ... 84, 85
Cryptohypnus ... 89

Page

Cryptorhynchus 71, 107
Culex 116
Cybister 82
Cyclops 117, 141, 142, 150, 151, 158
Cymbiodyta 83
Cyphon 88
Cyrtophorus 98
Cytilus 88

D.

Dacne 86
Dendroides 105
Dermestes 87
Deronectes 80
Diabrotica 101
Diapernus 103
Diaptomus 117, 141, 150, 151, 158
Dicaelus 75
Dicerca 91
Dichelonycha 95
Dicranidius 89
Dina 118
Dineutes 82, 117
Diplochila 75
Diplotaxis 95
Disonycha 101
Dolopius 90
Donacia 100, 116
Dorcas 94
Dorytomus 106
Drasterius 90
Dromogomphus 46, 47, 50, 55, 56
Drosera 14
Dulichium 115
Dytiscus 81, 82 117, 132

E.

Elaphe 63
Elaphidion 97
Elaphrus 72
Elater 89, 90
Eleocharis 115
Elliptoma 93
Ellychinia 92
Elodea 115, 130 131
Enallagma 45, 55, 56, 117
Enchodes 104
Enicmus 88
Epiaeschna 49, 55, 56
Epicauta 105
Epicordulia 51, 55, 56
Epigaea 114
Epipactis 114
Epuraea 88
Epiaeschna 48, 55, 56
Equisetum 14, 137
Ericaulon 14, 16, 24
Eriophorum 116
Erobdella 118, 135
Eros 92
Erycus 106
Esox 23, 27, 29, 31, 32, 33, 34, 35, 148, 155
Etheostoma 21, 24, 32, 33, 151, 156
Eucalia 14, 17, 23, 149
Eucinetus 88
Eucrangonyx 117
Eumeces 63
Euphoria 96
Eupomotus 28, 29, 30, 31, 32, 33, 34, 35, 36
Eupsalis 108
Eustrophus 104

F.

Fontinalis 20
Fornax 88
Fundulus 149

G.

Galerita 77
Galeruca 101
Gastroidea 101
Gaultheria 114
Gaurotes 98

Page

Gaylussacia . . . 116
Gerris . . . 117, 126
Geopinus . . . 79
Glototrichia . . . 14
Glossiphonia . . . 118
Gomphoides . . . 46, 47, 55, 56
Gomphus . . . 46, 47, 48, 55, 56, 117, 126, 135
Graphoderus . . . 82
Graptemys . . . 63
Grypidius . . . 106
Gymnetron . . . 107
Gynandropus . . . 79
Gyrinus . . . 82, 117, 137, 138

H.

Hadropterus . . . 151
Haemonia . . . 100
Haemopsis . . . 118, 126, 132, 135, 137
Hagenius . . . 46, 47, 55, 56
Hallomnus . . . 104
Haltica . . . 101
Haplandrus . . . 102
Harmonia . . . 85
Harpalus . . . 70, 79
Helochares . . . 83
Helophorus . . . 82
Heptagenia . . . 116, 137
Hetaerina . . . 42, 43, 55, 56
Heterocerus . . . 88
Hiodon . . . 154
Hippodamia . . . 85
Hister . . . 87
Hololepta . . . 87
Hoplia . . . 95
Hyalella . . . 117, 133
Hybognathus . . . 146
Hydaticus . . . 81
Hydnocera . . . 93
Hydrobius . . . 83
Hydrocharis . . . 83
Hydrochus . . . 82
Hydrophilus . . . 82
Hydroporus . . . 80, 81
Hylobius . . . 106
Hymenorus . . . 103
Hypericum . . . 114
Hyperodas . . . 106
Hyperplatys . . . 99
Hypophloeus . . . 103

I.

Ictalurus . . . 155
Ilybiosoma . . . 81
Ilybius . . . 81
Impatiens . . . 114
Iphthimus . . . 102
Ips . . . 88
Iris . . . 115
Ischyrus . . . 86
Ishnura . . . 45, 46, 55, 56
Isomira . . . 104

J.

Juniperus . . . 114

L.

Laccophilus . . . 80
Lachnocrepis . . . 78
Lachnosterna . . . 96
Ladonia . . . 117
Lapidomera . . . 100
Larix . . . 116
Lathyrus . . . 114
Lebia . . . 77
Ledum . . . 114
Leporinus . . . 17, 18, 20, 23, 28, 29, 32, 33, 34, 35, 36, 150
Leptinotarsa . . . 100
Leptostylus . . . 99
Leptura . . . 98, 99
Lepturges . . . 99
Lepyrus . . . 105
Lernaepoda . . . 23
Lestes . . . 43, 44, 55, 56

Page

Lethocerus 117
Leucichthys 141, 142, 153
Leuciscus 17, 18, 19, 23, 125, 126, 127, 131, 132, 133, 134, 135, 136, 146, 156, 157
Leucorhinia 117, 132
Libellula 52, 54, 55, 56, 117, 132
Ligyrus 96
Limonius 91
Liopus 99
Lissorhoptrus 106
Listronotus 105, 106
Litargus 87
Lithocurus 135
Lobelia 16
Loricera 73
Lota 32, 33, 152
Lucanus 94
Lucodota 92
Ludius 90

M.

Macrobasis 105
Macrobdella 14, 16, 18, 118, 126
Macrodactylus 95
Macromia 51, 55, 56
Magdalis 107
Mancasellus 117, 137
Marchantia 14
Matus 81
Megalodacne 86
Megilla 85
Melandrya 104
Melanophila 92
Melanotus 90, 91
Meracantha 103
Metachroma 100
Micropterus 16, 17, 18, 19, 24, 29, 30, 31, 32, 33, 34, 35, 155
Molochrus 97
Monarthrum 108
Monocepidius 89
Monohammus 99
Mordellistena 104
Mycetophagus 87
Mycterus 104
Myenia 118, 135, 137, 138
Myrica 15, 20, 115, 130, 133
Myriophyllum 14, 20, 27, 28, 115
Mystacides 123
Myxobolus 18, 22

N.

Nanus 107
Necrophorus 84
Necturus 62
Nehalennia 45, 55, 56
Nostoc 115
Notonecta 117
Notropis 21, 23, 30, 32, 33, 34, 35, 36, 147, 155
Nyctobates 102
Nymphaea 28, 29, 115, 130

O.

Oberea 100
Ochodaeus 94
Oedionychis 101
Olisthropus 77
Omophron 72
Oodes 79
Ophiogomphus 46, 47, 55, 56
Ophrydium 118
Orthosoma 97
Otiorhynchus 105

P.

Pachybrachys 100
Pachydiplax 52, 54, 55, 56
Pachylobius 106
Pandeletejus 105
Parandra 97
Passalus 94
Patrobus 73
Pelidnota 96
Penthe 104
Perca 17, 19, 21, 24, 28, 29, 30, 31, 32, 33, 34, 35, 36, 150

Page
Percina 30, 33, 34, 156
Percopsis 28, 29, 30, 33, 34, 35, 36, 155
Phegopterus 114
Philhydrus 83
Philonthus 84
Photinus 92
Photuris 92
Phyllobrotica 101
Physa 118, 132, 133, 134, 135, 138
Physocnemum 97
Phytolacca 114
Phytonomus 105
Picea 114
Pimephales 14, 21, 22, 30, 33, 146, 154
Pincodera 77
Pinus 114
Pisenus 104
Pissodes 106
Pityobius 91
Placobdella 118, 126, 132, 137
Planorbis 118, 133, 134
Plathemis 117, 134
Platycerus 94
Platyderma 103
Platynus 75, 76, 77
Platypeltis 63
Poecilonota 91
Polygonum 115
Populus 114
Potentilla 116
Potomogeton 14, 16, 18, 20, 27, 28, 29, 115
Prionocyphon 88
Prionus 97
Prunus 114
Pseudomus 107
Psnocerus 99
Psyllobora 86
Pterostichus 73, 74
Ptilinus 93
Purpurescens 97
Pygosteus 14, 23, 149

Q.

Quercus 114

R.

Rana 14, 62, 118
Rhantus 81
Rhinichthys 16, 17, 18, 19, 20, 33, 147, 148
Rivularia 115
Roccus 156
Rubus 114

S.

Sagittaria 115, 137
Salix 114
Salmo 143, 154
Salpingus 104
Salvelinus 23, 33, 143
Saperda 99
Saprinus 87
Sarracenia 115
Scarites 73
Scirpus 31, 32, 115
Scutellaria 114
Semotilus 16, 17, 18, 19, 20, 33, 146
Serica 95
Sericosmus 91
Serropalpus 104
Sialis 117
Silpha 84
Simcronyx 106
Solenophorus 79, 80
Somatochlora 117, 126, 132, 133, 134, 135
Sparganium 16, 18, 20, 24, 115
Sphaerium 118, 133
Sphagnum 115, 116
Sphenophorus 108
Spirogyra 21, 115
Spongilla 14, 17, 118, 126, 132, 133, 137
Staphylinus 84
Stenolophus 79
Stentor 118, 126

Page

Stephanocleonus 106
Stilicus 85
Stizostedion 155
Stomoxys 116
Storeria 63
Strangalia 98
Strigoderma 96
Sympetrum 52, 53, 54, 55, 56, 117
Synchroa 104

T.

Tachypterus 107
Telephorus 92, 93
Tenebrio 102, 103
Tetragoneuria 16, 51, 55, 56, 117, 133
Tetraopes 100
Thanuophis 63, 118
Thaneroclerus 93
Tisactia 86
Tolypothrix 20
Tragosoma 97
Tramea 40, 52, 54, 55, 56, 57
Trichodes 93
Trichus 97
Tritoma 86
Tropisternus 83
Tyloderma 107
Typocerus 98

U.

Ulothrix 123, 124, 141, 145
Umbra 32, 33, 148
Upis 102
Uranidea 156
Urographis 99
Utricularia 20, 115

V.

Vaccinium 114, 115
Vaucheria 115, 138

X.

Xantholinus 84
Xanthonia 100
Xyletinus 93
Xylopinus 102
Xyloryctes 96
Xylotrechus 98

Z.

Zygnema 21, 115

D. H. HILL LIBRARY
North Carolina State College

North Carolina State University Libraries
QH105 .M5 A3 no.4
MISCELLANEOUS PAPERS ON THE ZOOLOGY OF MICHIG
S02775420 C